INDUSTRIAL RADIOACTIVE WASTE DISPOSAL

HEARINGS

BEFORE THE

SPECIAL SUBCOMMITTEE ON RADIATION

OF THE

JOINT COMMITTEE ON ATOMIC ENERGY

CONGRESS OF THE UNITED STATES

EIGHTY-SIXTH CONGRESS

FIRST SESSION

ON

INDUSTRIAL RADIOACTIVE WASTE DISPOSAL

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NOTE

This is Volume 4 of four volumes of the record of "Hearings on Industrial Radioactive Waste Disposal." It discusses the activities of Federal and State governmental agencies in radioactive effluent control and administrative relationships between these agencies. The international aspects of the problem are also dealt with in this volume. Volume 1 covers the portion of the hearings concerned with the origin and nature of various types of radioactive wastes evolved from nuclear energy activities and operations in use to manage these wastes at various AEC and other installations. Volume 2 deals with the first half of the current waste disposal research and development program. It describes and discusses the treatment and controlled dispersal of low and intermediate level wastes to the atmosphere, surface waterways, the ground, and the ocean and environmental investigations associated with this phase of the development program. Volume 3 covers the second half of the current waste disposal research and development program. It describes and discusses the handling, treatment, and proposed ultimate disposal systems for highly radioactive wastes that are primarily evolved from irradiated fuel reprocessing plants and discusses the future estimates and economics of disposal of radioactive wastes. It also includes a summary of environmental factors related to these estimates and a discussion of the industrial viewpoint of the radioactive waste problem.

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INDUSTRIAL RADIOACTIVE WASTE DISPOSAL

TUESDAY, FEBRUARY 3, 1959

CONGRESS OF THE UNITED STATES,
SPECIAL SUBCOMMITTEE ON RADIATION,
JOINT COMMITTEE ON ATOMIC ENERGY,
Washington, D.C.

The Special Subcommittee of the Joint Committee on Atomic Energy met at 10 a.m., pursuant to recess, in room P–63, the Capitol, Hon. Chet Holifield, chairman of the special subcommittee, presiding.

Present: Representatives Holifield (chairman of the special subcommittee), Durham (chairman of the committee), and Hosmer.

Also present: James T. Ramey, executive director; David R. Toll, staff counsel; and Dr. Walton Rodger, technical adviser of the Joint Committee on Atomic Energy.

Representative HOLIFIELD. The committee will be in order.

The first witness this morning will be Mr. H. L. Price, Director, Division of Licensing and Regulation of the AEC. Please proceed, Mr. Price.

STATEMENT OF H. L. PRICE,[1] DIRECTOR, DIVISION OF LICENSING AND REGULATION, U.S. ATOMIC ENERGY COMMISSION

Mr. PRICE. I have a statement on the Commission's regulatory program, Mr. Chairman, which I believe has been submitted to the committee, and with your permission I will read it.

In discharging its responsibility to regulate and license private atomic energy activities so as to protect the public health and safety, the Commission has developed and placed into effect a comprehensive system of regulations governing the construction and operation of reactors and other nuclear facilities, and the possession and use of source, special nuclear, and byproduct materials (radioisotopes).

Briefly the regulations provide that no person within the United States shall transfer or receive in interstate commerce, manufacture, produce, transfer, acquire, possess, or use, any production or utilization facility or any source, special nuclear, or byproduct material except as authorized by a license issued by the Commission. The regulations also prescribe such things as the information which must be submitted by applicants for licenses; the criteria for radiation protection; the criteria for issuance of licenses; rules respecting the trans-

[1] Born Luray, Va., July 3, 1906; A.B. and LL.B. degrees, University of Virginia; began practice of law at Roanoke, Va.; served with the Department of Agriculture and the War Production Board; became associated with the Atomic Energy Commission as Assistant General Counsel at Oak Ridge in 1947; became Deputy General Counsel of the Commission in 1951; Special Assistant to the General Manager of the Commission for Licensing in 1954; Director, Division of Civilian Application, 1955–57; Director of Licensing and Regulation since December 1957.

fer of licensed materials; recordkeeping requirements; and rules relating to the amendment, modification, suspension, or revocation of licenses.

Title 10, Code of Federal Regulations, Part 20, "Standards for Protection Against Radiation," is the basic regulation dealing with radiation protection and applies to all persons who receive, possess, use, and transfer source material, special nuclear material, or by-product material under a general or specific license from the Commission. It prescribes the standards and precautionary procedures for the protection of the licensee, his employees, and the public from radiation hazards. The standards specify the maximum radiation doses to which individuals may be exposed, maximum permissible radiation levels in unrestricted areas, maximum concentration values for the discharge of radioactivity into air and water and permissible methods and concentrations for the disposal of radioactive waste. The safety procedures prescribed in the regulation include requirements for personnel monitoring, radiation surveys, posting of areas and equipment with radiation caution signs, introduction of personnel and recordkeeping.

The "Standards for Radiation Protection" are designed to conform with the recommendations of recognized technical authorities, such as the National Committee on Radiation Protection and with the Commission's safety experience in its own operations.

Mr. TOLL. Mr. Price, on your conformance with the recommendations of the NCRP: Do your regulations conform exactly, or are there some variations between AEC regulations, Part 20, and the NCRP recommendations?

Mr. PRICE. I don't think there are any substantial variations. For example, I believe that we have accepted without change the numbers, that is, the exposure limits and concentrations.

Now, we may have had to convert some of those numbers, because we are dealing with the licensee, and we have got to use numbers that tell him how much radioactivity and in what concentrations he can let the material leave his plant, either in air or in water. And those numbers are fixed, so that we feel assured that nobody in the surrounding area will get an exposure in excess of the limits recommended by the NCRP.

So I do not believe there is any variation so far as the technical recommendations are concerned.

Mr. TOLL. As I recall, Professor Frampton, in his Law Review article did point up some differences, primarily as to the age of the people covered.

Mr. PRICE. There are some administrative differences. There is in existence a recommendation of the NCRP, which is I understand now being reviewed with the possibility of revision, a recommendation in the form of a proposed code. We used that as a basis for this regulation that I have been describing, but we probably did not use all of the administrative mechanisms and requirements.

I mean, we probably thought that some of them did not quite lend themselves to a mandatory rule; but so far as the exposure limits are concerned, I do not believe there is any difference between us and the NCRP.

Mr. TOLL. Are the States encouraged to use the NCRP recommendations?

Mr. PRICE. That is right. They are. And they are also encouraged to take the technical recommendations of the NCRP. I expect that what has happened is that in most of the States that have adopted this kind of regulation, they have probably followed the pattern of this handbook, Handbook 61 I think, which we used as a pattern also. And as a result of that, there may be some minor differences.

I have read Professor Frampton's Law Review article, and I know that there are these differences between the States, and between the States and us; but I think it is our feeling that these are differences of minor detail.

Certainly the States and we are conscious of the importance of uniformity here, and I do not think any of us feel that the situation from the standpoint of differences is any cause for alarm at the present.

It is something that we and the States want to continue to watch out about.

Mr. TOLL. Thank you.

Mr. PRICE. Because of the varied and complex technical problems which must be considered in the disposal of significant quantities of radioactive waste, the Commission's regulations do not attempt to spell out detailed standards in this area. Rather, they establish permissible concentrations in effluents to unrestricted areas and provide for the disposal of only nominal quantities of nuisance waste by release into sanitary sewerage systems and by burial in soil, on a routine basis. These levels of activity are so low as to be considered permissible under any conceivable conditions of disposal. The regulation provides that the Commission will consider alternative methods and higher levels of waste disposal on an individual case basis.

The permissible concentrations in effluents to unrestricted areas are low. Persons in unrestricted areas could continually breathe the air and drink the water containing these concentrations without exceeding the permissible radiation dose during their lifetime. The regulations are based on the fact that the licensee has no control over the ultimate fate of the radioactivity after it leaves his premises, and, therefore, the limit on concentrations is placed on the effluent as it leaves the licensee's control and enters an unrestricted area. This does not allow the licensee to take advantage of the additional dilution available in streams and in air in an unrestricted area without specific approval from the Commission.

However, a licensee may take advantage of environmental dilution by proposing in an application to the Commission, higher limits upon concentrations of radioactive material to be released into air or water in unrestricted areas as a result of his activities. The Commission will approve the proposed limits if the applicant demonstrates that it is not likely that after dilution with available environmental media, any individual will be exposed to concentrations in excess of the permissible limits. This section of the regulation adopts the principle of using the environment for dilution of the concentrations of radioactive materials to a safe level. It is intended to provide for safe release from nuclear facilities and radioisotope laboratories of various low-level wastes that cannot be economically processed or treated and for which a suitable environmental condition exists.

It is not intended as a means of disposing of significant quantities of waste that can be economically processed or treated prior to disposal. The regulation also specifies small quantities of nuisance waste that may be disposed of in sewers and buried in soil.

Procedures are incorporated in the regulation whereby any licensee or applicant for a license may apply to the Commission for specific approval of proposed procedures to dispose of licensed material in a manner other than as generally authorized in the regulations. The applicant must include a description of the radioactive material, including the quantities and kinds of material, and the proposed manner and conditions of disposal. The application must include a detailed analysis and evaluation of pertinent information as to the nature of the environment, including topographical, geological, meteorological, and hydrological characteristics; usages of ground and surface waters in the general area; the nature and location of other potentially effected facilities; and procedures to be observed to minimize the risk of unexpected or hazardous exposures. The Commission may approve such disposal procedures where the circumstances of the particular case are such as to provide adequate safeguards to public health and safety.

The Commission's regulatory program does more than establish standards which represent the basic ground rules under which atomic energy activities must operate. It is intended to provide reasonable assurance that the standards which have been established to protect health and safety will, in fact, be met. This is accomplished in two ways. First, through a licensing procedure to determine the adequacy of the applicant's proposed health and safety measures prior to operation of a nuclear facility or possession and use of the radioactive material; and, second, through an inspection program to determine compliance with the applicable regulations and licensing conditions after receipt of the material.

LICENSING PROCEDURES

Each applicant for a license to construct and operate a nuclear facility or to possess and use source, special nuclear or byproduct materials, must provide information on equipment and facilities available, training and experience of personnel, safety procedures and a detailed hazard analysis of his proposed operation, which will provide, to the Commission's satisfaction, reasonable assurance that the licensed activity will not present undue risk to public health and safety, either from accidental release of radioactive materials or release from routine operations or from disposal of radioactive waste.

The information and technical data submitted by the applicant is given a thorough review by the Commission's technical staff composed of persons competent in the field of reactor hazards, radiation protection, and waste disposal. In addition, the advice and recommendations of the Advisory Committee on Reactor Safeguards are sought on all proposed power and testing reactors and on other reactors which present new or unusual safety considerations. If necessary, conferences are held between the AEC staff and the applicant's staff to resolve difficult questions that arise in the hazards review. Particular attention is given in the analysis to the radioactive efflu-

ents which will be discharged to unrestricted areas to assure that the safety standards will be met. If the applicant desires to discharge effluents which exceed the concentrations specified in the part 20 regulation for release of effluents into unrestricted areas, he must provide sufficient information on the various environmental parameters to provide reasonable assurance that individuals in the unrestricted areas will not be exposed to concentrations of radioactive materials above those permissible under the regulations.

METHODS OF DISPOSAL

At present time, the primary source of radioactive waste from licensee operations is from byproduct materials being used in medicine, research, and industry and effluent waste from licensed facilities. The types of waste generated have been characterized in earlier testimony. All of it is of a low-level nature. For the foreseeable future, all high-level waste resulting from processing of spent fuel elements from licensed reactors will be returned to the Commission for processing and handling.

In practice, the most common disposal methods and procedures used by licensees, other than disposal by sewer and burial in soil as provided for in the regulations, are:

1. Return of radioactive waste to AEC installations.
2. Disposal at sea.
3. Treatment by incineration.
4. Transfer to commercial disposal firms.

A. Return of radioactive waste to AEC installations: Since the beginning of the AEC's isotope distribution program in 1946, the Oak Ridge National Laboratory has provided a waste disposal service for AEC radioisotope licensees. The waste must be packaged in accordance with ICC regulations and requirements of the Oak Ridge National Laboratory. The packaged waste is shipped by rail or truck to the Oak Ridge National Laboratory for ground burial. This provides a means of disposing of some solid waste materials for licensees that are within economical shipping distance. One license has been granted to a private concern to collect waste from other AEC licensees and ship it to Oak Ridge National Laboratory for final disposal.

B. Disposal at sea: In 1954, the National Committee on Radiation Protection's recommendations on radioactive waste disposal in the ocean were published in National Bureau of Standards Handbook 58. The Commission has generally followed these recommendations in issuing licenses for disposal at sea. In brief, the criteria provide that disposal shall be in a minimum of 1,000 fathoms of water and the waste shall be packaged in such a manner that under the conditions of handling and shipment the package cannot be easily damaged or broken and will reach the ocean bottom without appreciable loss of contents. The package must have sufficient density to insure sinking to the ocean bottom and must have sufficient shielding to allow safe handling. The package must be appropriately labeled for identification purposes. Packages must conform to applicable shipping regulations of the Interstate Commerce Commission and Coast Guard and conditions of the AEC license. There have been exceptions to these

recommendations with respect to depth of disposal on the merits of individual cases.

The requirement for disposal of package waste in 1,000 fathoms of water does not present a serious problem to licensees on the west coast of the United States because of the narrow shelf and the great depth of the Pacific Ocean at a relatively short distance from the coastline. However, it does present a serious economic problem for those on the east coast because of the long distances (100 to 150 miles) the waste must be transported to reach the edge of the Continental Shelf and depths of 1,000 fathoms.

From technical information available, it now appears that low levels of packaged radioactive waste of the type and quality generated by source and byproduct licensees could be disposed of in depths of water less than 1,000 fathoms in selected areas on the Continental Shelf.

Because of the wide interest of licensees in disposing of low levels of waste in the Atlantic Ocean the Atomic Energy Commission, in cooperation with the National Science Foundation, Fish and Wildlife Service, and Office of Naval Research, has supported a study by the Committee on Oceanography of the National Academy of Science to consider the feasibility of establishing designated ocean dumping areas along the Atlantic Ocean on the Continental Shelf. Preliminary information indicates that a favorable report designating such areas may be forthcoming in the near future. A similar study is being conducted for the Pacific Ocean off the coast of California. AEC licensing for sea disposal will be reevaluated in light of these studies.

C. Treatment by incineration: Waste treatment by incineration under controlled conditions may be authorized by the Commission. Treatment by incineration is limited to low level combustible solids such as paper, linens, and small animal carcasses. This treatment reduces the bulk of the waste and is used primarily by research laboratories and hospitals. Residues, if any, are usually collected and buried.

D. Land burial: To date, the Atomic Energy Commission has not issued a license for the commercial disposal of radioactive waste by land burial. Land burial service for licensees has been provided by the Oak Ridge National Laboratory and the Oak Ridge Operations Office on an accommodation basis under a charge of a fixed fee per package. However, large, solid waste volumes and repeated requests for land burial service have become an increasing operational and administrative burden to Oak Ridge National Laboratory during the past 2 years. This condition has been caused primarily by the rapid expansion of nuclear energy uses in the northeastern area of the United States. Approximately one-half of all isotope shipments in the United States are made to the region encompassing Massachusetts, Connecticut, Rhode Island, Maine, New Hampshire, New York, New Jersey, Delaware, Pennsylvania, Maryland, Ohio, Indiana, Illinois, Michigan, and Wisconsin.

In addition, over 50 percent of the research and test reactors being planned or built primarily for research purposes are located in this area. Approximately 75 percent of the power reactor projects being planned or constructed are concentrated in this approximate area. These conditions point strongly to the need for the establishment of a regional radioactive waste burial ground in order to provide the most

adequate and economic means for packaged solid-waste disposal. Technical criteria are being developed and preliminary survey work on site selection for such a burial ground has been accomplished at several locations. An AEC-licensed commercially operated burial ground may be feasible.

However, there are major administrative problems pertaining to the relationship between the Atomic Energy Commission and a commercial concern which would operate such a facility. For example, consideration must be given to the long-term responsibility of maintaining a burial ground for radioactive materials. Because of the type, level of activity, and half-life of the radioactive wastes, it may be necessary to maintain land burial areas for an extended period of time, perhaps hundreds of years. The feasibility of a commercially operated burial ground under AEC license is largely dependent upon resolution of this problem.

E. Commercial waste disposal agencies: The Atomic Energy Commission has issued licenses to eight commercial firms to collect, package, transport, and dispose of radioactive waste generated by licensees. A list of these licensees is attached to this statement. Six of these companies propose to ultimately dispose of the waste at sea and one commercial concern collects and packages the waste and ships it to the Oak Ridge National Laboratory for land burial. One license has been issued for storage of low levels of radioactive waste.

Each application from a concern to provide a commercial waste-disposal service is thoroughly reviewed to assure radiation health and safety from the point of collection of the waste at the licensee's facility, transportation of the material to the commercial concern's processing area, processing, packaging, and storing of the waste, transporting of the waste to the disposal area, and final disposal.

Because of the wide public interest in radioactive materials reaching the environment, the AEC follows the policy of publishing the receipt of applications and proposed issuance of commercial waste disposal licenses in the Federal Register. An opportunity is thereby afforded State and local officials and other interested parties to be fully informed and to request a hearing on such actions if they so desire. To date, the Commission has held hearings on the proposed issuance of licenses to dispose of waste in the ocean of two applications.

Inspection: All licensees are subject to periodic inspection by the AEC to assure that the regulations and the terms and conditions of licenses are being complied with.

Each licensee is required to maintain complete records of receipt, use, transfer, and disposal of all radioactive materials. If radioactive materials are disposed of through effluents into the air or water, records of average concentrations discharged must be kept. Disposal to the sewer and by burial in soil in accordance with the Part 20 regulation must also be recorded. Also, the types and quantities of activity transferred to a commercial waste disposal concern must be recorded. Concerns licensed to dispose of wastes commercially must maintain records of types and quantities of radioactivity received and the location and date of disposal. These records, together with the licensee's operating procedures, are carefully reviewed by the inspector to assure compliance with regulations and the terms and conditions of the license.

If inspection discloses evidence of noncompliance, appropriate action is taken promptly by the Commission to assure that the licensee corrects the deficiencies. If necessary, the Commission may issue an order under its rules of practice requiring the licensee to take appropriate corrective action. Under the Atomic Energy Act of 1954, the Commission has authority to take procedural action to revoke, suspend, or modify any license where such action is necessary, to assure protection of health and safety to the public.

Review of policies and standards: The radioactive waste generated in AEC licensee operations to date have been low-level, small-volume waste. We believe that the policies and standards established by the Commission for disposal of radioactive waste by AEC licensees provide, in accordance with present knowledge, a substantial margin of safety to the public.

However, as additional reactors go into operation and the use of radioactive isotopes increases, the trend will be toward ever-increasing quantities of waste. The disposal of large volumes of radioactive waste presents complex problems. It will be necessary to continue to support research work in such areas as sea disposal and disposal of low-level, high-volumes of waste into the environment.

The policies and standards of the Commission in the field of radioactive waste disposal are under continuous review and are subject to change with the development of new knowledge.

(The appended material follows:)

Firms licensed to provide a commercial waste disposal service

License No. and expiration date	Institution	Type of material authorized	Possession limit
4-748-4 Jan. 31, 1959	American Electronics, Inc., Reed-Curtis Nuclear Ind., 9459 West Jefferson Blvd., Culver City, Calif.; Mr. Larry R. Curtis.	Byproduct material atomic Nos. 3-83, inclusive, and source material.	10 curies.
20-685-2 Aug. 31, 1958 (renewal pending).	Crossroads Marine & Salvage Co., Boston, Mass.; Mr. George C. Perry. Port: Boston, Mass.	Byproduct material atomic Nos. 3-84, inclusive, and source material.	Byproduct material, 20 curies; source material, 4,000 pounds procurement limit.
4-3766-1 Sept. 30, 1960	Nuclear Engineering Co., Inc., 2800 North Main St., or Naval Industrial Reserve Shipyard, Kearny, N.J.; Walnut Creek, Calif.; Mr. J. E. Law.	Byproduct material, source material, and special nuclear material.	Byproduct material, 800 curies; special nuclear material, 4 grams, source material, 2,000 pounds.
4-580-6 Aug. 31, 1960	Isotopes Specialties Co., 170 West Providencia, Burbank, Calif.; Mr. Allen Goldstein.	Byproduct material and source material.	Byproduct material, 100 curies; source material, 2,000 pounds.
20-3541-1 Sept. 30, 1960	New England Tank Cleaning Co., 135 1st St., Cambridge 41, Mass.; Mr. E. W. Denault, Jr. Port: Boston, Mass.	Byproduct material, source and special nuclear material.	Byproduct material, 1,000 curies; source material, 50 pounds; special nuclear material 5 grams.
46-3623-1 Aug. 31, 1960	American Mail Line, Ltd., 740 Stuart Bldg., Seattle 1, Wash.; Mr. M. V. Walker. Port: Seattle, Wash.	Byproduct material and source material.	Byproduct material, 10 curies, source material, 15 pounds procurement limit.
31-1672-1 Dec. 31, 1960	Radiological Services Co., 28-22 Astoria Blvd., Long Island City, N.Y.; Mr. Herman Glasser.	Atomic Nos. 1-83 and source material waste, ORNL.	Byproduct material, 20 curies, except tritium, 900 megacycles, source material, 15 pounds.
4-37-2 Apr. 30, 1959	Atomic Energy Waste Disposal Service, 5410 Bond St., Oakland 1, Calif.; Mr. Russ Simpson.	Atomic Nos. 3-83, inclusive, and source material, storage only.	1 curie.

Representative HOLIFIELD. Thank you, Mr. Price.

How many employees are in your Division of Licensing and Regulation?

Mr. PRICE. Mr. Holifield, the total employment is 101. In addition two new appointees are due to report for duty by February 15.

Representative HOLIFIELD. A total of 103.

Mr. PRICE. That is clerical and secretarial and professional included.

Representative HOLIFIELD. How many of those are devoted to the formulation of regulations, and how many are devoted to actual policing of the compliance to the regulations?

Mr. PRICE. First, Mr. Holifield, the policing of compliance is handled by the Inspection Division, which is a separate Division.

Representative HOLIFIELD. How many do they have? How many employees?

Mr. PRICE. The figure is 43 inspectors and 20 clerical employees.

Representative HOLIFIELD. You will have 103 in the Regulation Division?

Mr. PRICE. In Regulation and Licensing, yes, sir.

Representative HOLIFIELD. Are these people constantly traveling around the country seeing that these regulations are complied with, or are they resident here in Washington?

Mr. PRICE. The people in my Division, in Licensing and Regulation, are mostly here in Washington. They may go out and visit an installation in order to gather information that they need in the review of a licensing application, or they may go out as part of a team to investigate an incident for purposes of gathering information useful in the administration of the regulatory program. But the traveling around for purposes of compliance inspection—that is done by the Inspection Division, which is separate.

Representative HOLIFIELD. Is the Inspection Division independent of the Licensing and Regulation Division?

Mr. PRICE. That is right.

Representative HOLIFIELD. They function under their own autonomy and have no supervision from your agency? From your Division of Licensing and Regulation?

Mr. PRICE. That is right. The Director of the Inspection Division reports to the General Manager, and I report to the General Manager.

Representative HOLIFIELD. Who is the Director of the Inspection Division?

Mr. PRICE. Mr. Curtis Nelson.

Of course, we have to work closely together, because when they make an inspection of a licensee, if they find the evidence of noncompliance, this evidence is turned over to us, and then we take the steps to issue whatever orders, enforcement orders, are appropriate, setting up hearings and that sort of thing.

Representative HOLIFIELD. Or revoking the license?

Mr. PRICE. Or revoke the license; yes.

Representative HOLIFIELD. Do you consider the Licensing and Regulation Division as an objective and independent operating group, or are they influenced by policy decisions of the Atomic Energy Commission?

Mr. PRICE. Mr. Holifield, I consider them completely independent. The Commission has set the Licensing and Regulation Division up with no responsibilities whatever to build or construct reactors, or to administer any reactor or other programs, or to spend any money, or to make any contracts. We have none of that. We have no responsibilities whatever to promote any atomic energy activity other than the responsibility that we have by law to balance the needs of health and safety against the objective of having a national atomic energy program.

I consider and the Commission considers our Division completely separate, and we are, so far as the staff is concerned, the quasi-judicial arm of the Commission.

Representative HOLIFIELD. What is the attitude of industry toward your controls, both in the Licensing and Regulation, and Inspection Divisions?

Mr. PRICE. I am not sure that I will fairly characterize it. Let me say this, that I expect that many people in industry think that our regulations and licensing requirements are too strict.

On the other hand, I think there is a general recognition by all industry that we are dealing with a difficult new field, and if we err on the side of caution, it is probably justified.

Representative HOLIFIELD. Are you in receipt of constant complaints and criticisms of your regulation?

Mr. PRICE. No, sir.

Representative HOLIFIELD. In general, does industry seem to feel that they can live with and get along with your regulations?

Mr. PRICE. That is right. I would be the first to say that this is an area in which we have got to be forever on guard to be sure that we do not have unnecessary requirements; also to be sure that we have not overlooked something that is necessary; but I do not have any feeling that industry is completely unhappy.

Of course, industry basically does not like to be regulated for any purpose; but I think there is general recognition of the necessity for it here, and we get few complaints. But considering the fact that there are about 4,000 or 5,000 isotope licensees and a couple thousand other materials licensees, and then the facility licensees, I would expect that we would get a few complaints once in a while, and we do.

Representative HOLIFIELD. I am sure you do. But my question was directed toward whether there were a great number of these complaints and the general feeling that you were a little too tight on them, or whether there were just occasional complaints.

Mr. PRICE. From what I hear, and the people who have talked to me, it would be just occasional, very occasional; not frequent.

Representative HOLIFIELD. What position are you in, as the Regulating and Licensing Division, when it comes to approving a reactor site? What is the procedure there?

Mr. PRICE. The procedure there is that the applicant has to bring in an application for a license for a reactor at his chosen site with necessary hazards information, safety information, relating to the site, and enough information relating to his proposed reactor to be able to deal effectively with the site. We get that application, and then we have in my Division, under Dr. Clifford Beck, what we call a Hazards Evaluation Branch. These are technical people that look at all the hazardous aspects of a reactor project. They analyze it,

and on all power and testing reactors, and frequently on the other facilities, like the larger research reactors, the cases are also referred to the Advisory Committee on Reactor Safeguards.

They review it. The company is brought in to discuss the project with the Safeguards Committee and our staff. The Safeguards Committee makes a report to the Commission. My staff then works up a proposed position on the case.

If it is a research reactor, I can go ahead and act myself and issue the license, or deny it. If it is a power or test reactor—first, I have to give, even on research reactors, notice of proposed intention, so that any party or any applicant or any other person that might want to intervene could demand a hearing. Then we would have a hearing before a hearing examiner.

On the power and test reactors, we are required by law, whether anybody asks for a hearing or not, to set the case down for hearing before a hearing examiner, and in that case, from then on my staff is a party to the proceeding.

We take a position, representing the Government, the public interest as we see it. The applicant puts his case on the record. Any intervenors are allowed to come in and participate and object or support the application.

And then, on the basis of that record, the hearing examiner makes the decision, the intermediate decision, himself, and it is subject to appeal to the Commission.

In those cases I am completely separated from the hearing examiner and from the Commission. I mean, I only deal with them on the public record.

Representative HOLIFIELD. Let us take the case of the Piqua project. What was the chronology of that? Did you issue a license to those people to build the Piqua project or participate in it?

Mr. PRICE. No, sir. The Piqua project was one of those projects in—I forget whether it was the second or third round.

Representative HOLIFIELD. The second round.

Mr. PRICE. Anyway, it is a case where it was purely a contract negotiation matter, and it was not considered subject to licensing, because the Government was going to own the facility and because of the fact that it would be operated under Government contract pursuant to that second round program.

So they have never applied for a license, and I think it has been considered right along that they are not subject to license; that the safety aspects of that case would be handled under contract administration.

Even so, in the case of other Government-owned reactors, like the ones at testing stations and even the military reactors, we still review them.

The Commission causes them to be reviewed from the standpoint of safety, including site.

Last fall, or I guess it was late last summer, when sufficient information had been developed on the Piqua proposal, including the site, it was submitted to us for review, and we immediately looked at it in my Division, from the safety standpoint, and we immediately took it up with the Advisory Committee on Reactor Safeguards.

And I guess you are familiar with the chronology since then. The Safeguards Committee made a report that the initial site that was

proposed was not suitable. The case is still being reviewed, and consideration is being given to an alternate site.

Representative HOLIFIELD. Well, now, this negotiation has been going on for about 3 years.

Mr. PRICE. That is right, sir.

Representative HOLIFIELD. Part of the basic consideration of the Piqua people was that the site which they selected would be approved, which would enable them to utilize conventional turbines and generators.

It seems to me that somewhere along the line there has been a failure on the part of the Atomic Energy Commission to recognize that a prior determination as to safety of site should have preceded the negotiation of all of the corollary factors involved, in that Government-private party negotiation. We find ourselves at the end of 2½ or 3 years now with the original site apparently unsatisfactory, and this means that a new site has to be selected.

It could mean the complete withdrawal of the Piqua people from the project because of the failure to approve their first site. In any event, if they change, it means a great deal more expense to them, a great deal more negotiation, and planning on a different basis.

Has anything been done to preclude such a cart-before-the-horse operation as seems evident in this case?

Mr. PRICE. Yes, sir. In those early demonstration programs, the theory was that the Commission would get the proposal and work out the contract arrangements, which in all cases took several years—I mean, the money part of it—and then make it subject to a safety review. And then the result, as you just described, happened.

I think the plan is well accepted now that in future cases the persons proposing projects under these Government-participation programs, the demonstration programs, will be required to submit the site data and enough information about the reactor project at the very beginning before the Commission will act on the acceptability of the proposal under a demonstration program, so that I do not expect that this will happen on those cases again.

Of course, you realize now that this is something different than the licensing cases. The time when a licensee comes in is up to him. I mean, it is his money and his project, and, of course, they have all come in early, because they wanted to find out how they stood on those matters. And we have not had this problem in any of the license cases.

Representative HOLIFIELD. Well, that is true. However, let us get to this point of granting a license to non-Government users, in which the public interest is preserved by right of protest and by right of objective review.

Yet, on a governmental facility, how do you compensate for the protection of the public, the right to protest and the right to review? In this particular instance, it seems to me that the AEC takes over all arbitrary right to make the decisions, and there does not seem to be the same right of protest and right of objective review.

Mr. PRICE. Mr. Holifield, in the case of the Government-owned reactors, they are put through the same safety review within the Commission by the same people as the license cases. The same technical staff in my Division reviews them, and in those cases they go to the same Advisory Committee on Reactor Safeguards.

What does not happen is the administrative procedure that you mentioned, the right to a public hearing in those cases; and, of course, the law does not require that there be a hearing and these procedures except on the license cases.

All I can say is that we are aware, keenly aware, of the fact that to the general public a Government power reactor sitting out in the middle of the country looks like and acts just like a licensed reactor, and the public probably has some concern about it, and we have for a year tried to figure out the best way of affording the public a right to hearings here. There are a lot of complications to it, but I am sure for the future we will work out a procedure under which the public will have the same rights on these Government power reactor projects that they have on the licensed power reactor projects.

Representative HOLIFIELD. It is always to be assumed that the Government will act responsibly in its determinations, where it has the complete power, particularly in a field of this kind. However, it does seem to me that we have found in some instances the Government acting hastily; and where they have the power, they have sometimes utilized the power in an arbitrary way.

I can think of instances that have come within my own personal knowledge, of condemnation of areas for military use without the proper checking or the proper notification of local people. I have been on investigating committees that have investigated these occasions where the military moved in and exercised their arbitrary right of eminent domain without proper consideration of local conditions and local interests.

And certainly in this field here, where we are dealing with something where we have built very carefully a modus operandi which would protect the environment, the people in the surrounding area, from capricious use or capricious licensing and regulations, it certainly seems that a parallel method of protecting the people from their own Government should be involved; maybe not with the same administrative procedure, not bringing that under the Administrative Procedure Act, but certainly to the point of notification and the right of protest being given to responsible organizations or people in the immediate area.

Mr. PRICE. Mr. Chairman, we are committed to that proposition, and I have no doubt that for the future we will be able to work something out for these types of cases.

Representative HOLIFIELD. And we can be assured that there will be no future action such as occurred in the Piqua case, where the very important matter of site selection was almost overlooked and all the other areas of negotiation were entered into over a period of some 2½ years, and then suddenly we find that the site becomes the most important and the controlling factor, and there is an obligation to change the site.

When our committee was over in Europe, we looked into this matter, particularly in the Scandinavian countries and England, and we found out that basically nothing goes ahead until the site is determined. In other words, they put the cart where it belongs, behind the horse, it seems to me, and they determined first: is the site safe? Is it proper? And then they start negotiating on the other factors of it.

It seems to me this is just a commonsense way to proceed. I hope the Commission will proceed in that way in the determination of all sites, whether they be for private reactors or for Government-owned reactors, in the future.

Mr. PRICE. Yes, sir. Of course, as I understand the technical people, including the Safeguards Committee. you can look at a site and say it looks like a pretty good site, but you are still not willing to say for sure it is going to be all right until you know more about the design of the reactor, what kind of a reactor can be put in.

Representative HOLIFIELD. This is why I think that your designers and builders of reactors should be fairly well certain of the type of reactor that is going to be built, its size and potential hazard, according to type, before they set on a site; rather than to pick out a site and say, "We are going to build some kind of a reactor; we don't know what kind it is going to be; we don't know what its hazards will be or anything like that."

The study and presentation should occur before the selection of the site and not after the selection of the site, whether it is the Government or private industry.

Are there any further questions of Mr. Price?

If not, we thank you, Mr. Price, for your testimony.

Mr. PRICE. Thank you, sir.

Representative HOLIFIELD. We have another witness, Dr. D. E. Price of the U.S. Public Health Service.

Dr. Price, we are happy to have you before us this morning. You may proceed.

STATEMENT OF DAVID E. PRICE,[2] M.D., CHIEF, BUREAU OF STATE SERVICES, U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

INTRODUCTION

Dr. PRICE. The Public Health Service welcomes this opportunity to discuss its role in matters relating to radioactive wastes. Our activities have grown out of work in the field of water pollution based on both general and specific statutory authority, and our long-established responsibility for assisting the States in various health pro-

[2] Born in San Diego, Calif., in 1914, and received his M.D. degree at University of California School of Medicine in 1940. He is married and lives with his wife and two children, William and Janet, at 5215 Elsmere Ave., Bethesda, Md.

Assistant Surgeon General of the Public Health Service, U.S. Department of Health, Education, and Welfare.

Since October 1957, he has been Chief of the Bureau of State Services, one of the four major bureaus of the Public Health Service. Centered in this Bureau are the programs of financial grants to States, consultation and training services, and research and demonstrations which help State and community health departments to extend services and to carry out programs for the control of preventable disease and accidents, and the maintenance of a healthful environment.

Commissioned in the Public Health Service in 1941, and during the next 4 years had varied experience in State, local, and Federal health programs with special attention to venereal disease control.

In 1944, he entered Johns Hopkins University School of Hygiene and Public Health for graduate work in public health administration and received the Doctor of Public Health degree in 1946.

He was then assigned to the National Institutes of Health, the research arm of the Public Health Service. He was raised to the rank of Assistant Surgeon General when he became Associate Director of the National Institutes of Health in 1950.

In 1952, he was assigned to the Office of the Surgeon General, the administrative bureau of the Service, where he served until March 1957. Following a 6-month assignment (March–October 1957) as Deputy Chief of the Bureau of Medical Services, he assumed his present position.

grams. As the atomic energy program has developed, we also have enjoyed a close working relationship with the Atomic Energy Commission. The accomplishments and scope of these activities have been presented by Mr. James G. Terrill, Jr., Assistant Chief, Division of Radiological Health, in his paper, "Future Estimates and Economics of Waste Disposal—Summary and Evaluation of Environmental Factors," and by Dr. Ernest C. Tsivoglou, Senior Sanitary Engineer, Water Supply and Water Pollution, at the Robert A. Taft Sanitary Engineering Center, through his discussion on "Radioactive Waste Disposal and Surface Waterways."

I. The problem: As the future of the atomic energy industry unfolds, protection of the Nation's health will require consideration of possible exposures from substantial quantities of wastes from the processing and use of radioactive materials, as well as exposures from all other sources of natural and manmade radiation. In addition, the effects of radioactive wastes must also be considered as a part of the growing pollution load which is being placed upon the Nation's air and water resources.

The interest of the Service in this field has been intensified during the past few years by two important developments. First, there has been an increasing scientific concern over what may be the significent long-term deleterious effects of what have previously been considered "safe" radiation exposures.

The second factor is that the expanding production and use of atomic energy will inevitably increase the amounts of radioactive material escaping to the general environment. As nuclear power is more widely used, the amount of radioactive material produced will dwarf previous sources of ionizing radiation. Much of the radioactivity will be dissipated within the reactors, and another major portion will be handled at chemical processing plants and disposal areas. The immediate concern of the health agencies is the relatively small, but significant portion of the radioactivity which may not be dissipated or contained and thus may be discharged into the environment from reactor, chemical processing, and disposal operations.

When we dispose of nonradioactive chemical and biological wastes, we rely on the ability of the environment to absorb limited amounts of these materials within accepted environmental standards. However, in the case of radioactive wastes, the ability of the environment to absorb the significant materials has not been clearly defined, even though decay and dilution occur. After discharge, radioactive material may be reconcentrated physically, chemically, and biologically so its concentration may be increased as it passes through the environment to the point of human contact. These materials may also be stored in locations or enter ecological processes so their health significance becomes greater over the years. Therefore, if dilution techniques are to be permitted, continued and expanded research is necessary to evaluate the natural processes, including dispersion, retention, and reconcentration.

II. Legal authority: Section 301 of the Public Health Service Act (42 U.S.C. 241) directs the Surgeon General—

> to conduct research, investigations, experiments, demonstrations, and studies relating to the causes, diagnoses, treatment, control, and prevention of physical and mental diseases and impairments of man, including water purification, sewage treatment, and pollution of lakes and streams.

Radiation is well known to be a cause of impairments of man. Under the authority of this act, the Surgeon General cooperates with and renders technical assistance to States and other public authorities, scientific institutions and scientists, cooperates with and aids State and local authorities in enforcement of health regulations, and provides financial assistance by means of grants to States and political subdivisions to maintain public health services.

In addition, under the Federal Water Pollution Control Act (33 U.S.C. 466 et seq.), the Public Health Service provides technical services to States and municipalities, and supports technical research relating to the prevention and control of water pollution. Program grants are made to strengthen State water pollution control agencies, and construction grants are made to municipalities to stimulate construction of waste treatment works. Pollution of interstate waters endangering the health and welfare of persons in States other than that in which the discharges originate is subject to abatement under the act, and radiological contaminants are regarded as pollutants under this act.

The Congress made it clear in its delineations of responsibilities in water pollution control that primary responsibility rests with the States. The Federal Water Pollution Control Act of 1956, which is administered by the Public Health Service, declared it to be the policy of the Congress—

> to recognize, preserve, and protect the primary responsibilities and rights of the States in controlling water pollution * * *

and—

> * * * Nothing in this Act shall be construed as impairing or in any manner affecting any right or jurisdiction of the States with respect to the waters (including boundary waters) of such States.

Under the Air Pollution Research and Technical Assistance Act (42 U.S.C. 1857) the Surgeon General is authorized to prepare or recommend research programs and conduct technical research relating to the prevention and abatement of air pollution. Grants are made to States, public and private agencies, and individuals for research training and research projects in this field. Air pollution by radioactive materials is within the scope of this act.

III. Role of the Public Health Service: The role of the Public Health Service in protecting the public from the effects of radioactivity in wastes is not essentially different from its role in dealing with other health problems. The final responsibility under law for most aspects of health protection is vested in the States. The Public Health Service is charged with responsibility to stimulate and strengthen the States to use their powers for the promotion of effective administrative and sound technical programs. We consider this the basic function.

Nationally, however, there are a number of functions for the Public Health Service to perform which are generally beyond the power, competence, or resources of individual States. Principal elements of the developing Public Health Service program related to radioactive materials may be listed as follows:

(1) Assistance to States through consultation, technical assistance, demonstrations, assistance for special projects and training: For ex-

ample, during the past 3 years, nearly 500 persons have attended the nine radiological health training courses held each year at the Sanitary Engineering Center in Cincinnati.

(2) Dealing with interstate air and water pollution problems: For instance, at the request of the State Water Pollution Control Agency, which is in the State Health Department of New Mexico, the Surgeon General, as provided by the Federal Water Pollution Control Act, called a conference on April 29, 1958, in Santa Fe, N. Mex., on interstate water pollution in the Animas River. The principal concern of New Mexico was with wastes from uranium ore-processing operations at Durango, Colo. The conference of the official water pollution control agencies of New Mexico and Colorado and the Public Health Service was recessed for 1 year to permit development of a detailed report on the problem. On resumption of the conference, it is expected that the official control agencies will agree on whether or not there is interstate water pollution and, if there is pollution, a timetable for remedial action.

(3) Collaborating with other Government agencies or scientific groups to resolve problems which have a health component and which need to be dealt with at the national level, such as exposure tolerances, safe transport, uniform reporting, model legislation and codes, accidents and fire, etc.: In this area of activity, the Public Health Service has collaborated with the National Committee on Radiation Protection and Measurement through membership of its personnel in their activities for a number of years. It has also collaborated actively with the military, the Atomic Energy Commission, and the American Standards Association activities in their particular areas. Currently, we are using the NCRP standards as operating guides with the understanding that in particular situations where either large quantities of radioactive material or long-lived isotopes are involved, we may seek additional information before making a firm recommendation to the States. For instance, the Public Health Service recommended to both the Atomic Energy Commission and the State, levels of discharge of radioactive tritium below the current National Committee on Radiation Protection and Measurement standard, in connection with the waste discharge permit granted by the State Department of Health of Pennsylvania for the Shippingport reactor.

(4) Research, development, and research training in Public Health Service installations and by grants, contracts, and stipends: Public Health Service research activities most directly concerned with radioactive wastes have been conducted as intramural research, through cooperative projects with the Atomic Energy Commission at their sites, and through Division of Radiological Health research activities. While there have been no research grant funds specifically for radiological health, the National Institutes of Health has allocated $450,000 for research grants in the field of fundamental radiobiology.

(5) Radiological intelligence through nationwide networks for collection, analysis, and dissemination of data useful in assessing the radioactive contamination trends: Recognizing the urgent need for data on the amount of radioactivity in the environment, the Public Health Service is continuing to expand its program of measurement of radioactivity in air, water, and food. Such data have been requested by States and industrial users of radioactive material and

industries which can be affected by environmental radioactivity. They are necessary both to assess current exposure and to determine variations in this exposure as they occur gradually or as a result of sudden increases in radiation. At the present time, samples are taken at several hundred points through routine air, water, and milk network operations, and through the special radiation surveillance network sponsored directly by the Atomic Energy Commission.

(6) Public information: The information collected through radiation surveillance is made available to the public. For more technical use, a Radiological Health Handboook was developed by the Public Health Service. During the past year, over 7,600 copies were sold, and a fourth printing is currently in progress.

Research and investigations are carried out on both an intramural and extramural basis. Knowledge gained is correlated with other available information through liaison with other organizations. Training programs assist in the dissemination of radiological information to States, industry, and our own Public Health Service personnel as required. As public health organizations mature in this field of radiological health, better methods of securing and correlating information will become available, so that better facts on the overall relationship between sources and effects can be continuously gathered and evaluated. These in turn will serve as the basis for program direction, revisions in standards and health criteria, methods of assessment, control procedures, and public confidence.

The Public Health Service has a major role to play in the establishment of adequate and reasonable radiation standards. Ways must be found to assess radiation effects in the chronic, low-level range. Both apparent as well as calculated effects must be clearly delineated through knowledge of the normal health and disease patterns of the Nation. More precise and accurate methods must be determined for sampling and measuring the various radiations on a continuing basis to know the exposure picture accurately, and be able to assess its health effects. Until this work is done, for present planning and control purposes we must rely on established standards, calculations, and extrapolations which are subject to large errors because of inadequately known factors, principally of a biological nature.

Maximum contribution by the Public Health Service to the development of adequate radiological health programs requires many administrative and scientific competencies to achieve these important objectives. We have, therefore, established a Division of Radiological Health. Here we can concentrate on: Study of situations involving health-significant quantities of radioactive material; provide specialized assistance in the biological and physical sciences related to radiation exposure and effects; assess the overall radiation exposure of the public; maintain liaison with the specific industrial and Federal organizations planning activities which may disseminate relatively large quantities of radioactive material in the environment; keep the appropriate public health units alert to the implications of radiation problems and provide training and technical assistance.

Concurrently, we are promoting cognizance of radiological health activities in carrying out water supply and water-pollution control and air-pollution programs. Our Division of Sanitary Engineering Services has the responsibility of administering the Federal Water-

Pollution Control Act and the engineering aspects of the Air Pollution Research and Technical Assistance Act. In the water-pollution field, it is the responsibility of this Division to assist the States in developing comprehensive water-pollution control plans, provide technical assistance, undertake research which will increase our understanding of water-pollution problems, and plan satisfactory administrative and technical mechanisms for alleviating this pollution. The organizations with which this Division cooperates serve as the mechanism for evaluating all types of water-pollution problems including those involving radioactivity.

With regard to air and water pollution, the Public Health Service has always considered that its programs should emphasize those activities which support and complement the programs of State and interstate agencies, municipalities and industries so that a cooperative, well-balanced national pollution control program will result.

The health agencies must have a broad concept of radiological health, and be concerned with the total radiation exposures of the population, no matter what the sources of exposure may be. At the present time, for example, the exposure to radiation of a generalized community is, probably, from three major sources: natural background radiation, medical X-ray, and fission products. Health agencies will have to assess the importance of all of these sources from a public health viewpoint and continually work toward the objective of maintaining exposures of the public at the lowest practicable level. Additional sources of radiation should be admitted only when it is demonstrable that the useful purpose that will be served will offset any community hazard created by the anticipated increase in radiation exposures, and that the possibility of individual hazard is minimized by adequate control procedures.

We can summarize the present state of public health activities in this way: In view of the growing uses of atomic energy, the Public Health Service, and the States not only recognize their specific and general responsibilities for radiological health protection but are improving their competencies to cope with problems associated with the disposal of radioactive wastes.

Representative HOLIFIELD. Thank you, Dr. Price, for your statement.

Are there any questions from any members of the committee?

The basic act which sets up the Public Health Service and your long record of concern in fields which are interstate in character as well as intrastate, puts the Public Health Service in a very important position in this field of radiation, Dr. Price. I personally want to express my satisfaction at the fact that both in your statement here today and in conversations which I have had with you about this, the Public Health Service is recognizing its overall responsibility in the complete field of radiation; that it has set up a Division of Radiological Health in order to be able to concentrate on the specific dangers that are involved in this field.

As time goes on, it would seem logical that the wide scope of your interest in total radiation to mankind would more or less place in your organization the major responsibility.

At the present time, however, by Federal statute, as you know, the ownership and the custody and the public health safety responsibility

in the particular field of fission material is placed in the Atomic Energy Commission.

The thing that concerns me in the matter of releasing some of this proposed Federal responsibility from the Atomic Energy Commission and transferring it over to a body such as yours and to the States is the lack of appropriations and knowledge of the program which you need in order to do this job and actually do it right.

I am not only referring to the Public Health Service, but also to the respective States' functions. You would not at this time say that the Public Health Service has the appropriations and the competence of people to actually take over the responsibilities which are now being discharged by the Atomic Energy Commission, would you?

Dr. PRICE. No, I would not. The Public Health Service has a fairly rudimentary program that is designed, as I have attempted to point out here, very largely to help improve the competence of the State agencies in the health field to consider the problems that their citizens are confronted with, not only in the increasing development of the atomic energy industry, but in the exposure to a variety of other sources of radiation, with which the State health agencies must find themselves concerned.

Representative HOLIFIELD. I do not want you to pick out the few States that have an active program in this, but do you not find that on the general State level there is a lack of appropriations and a lack of competent, trained personnel to really do the job of policing and regulating and controling of this new hazard?

Dr. PRICE. Yes. The States are not as well equipped, either in appropriations or personnel, as they should be to assume their full responsibilities. We do not have as much precise information concerning this as we hope to have before very long. Our Division of Radiological Health, after its creation the 1st of July of this past year, has begun to survey the States and has now completed the study of State radiation control programs in some 13 States. I think that as time goes on, we will have a much better picture as to what the States are spending and how much they have in the way of personnel to contribute to this activity.

Representative HOLIFIELD. Without pinpointing individual States, is it a fair statement or question to ask you if in many of the States there has been over the period of years, a failure to adequately take care of existing health hazards, such as stream pollution and air pollution and other types of things that might affect the health and safety of the people?

Dr. PRICE. Yes, the field of stream pollution in particular has tended to lag, until the problem is quite far ahead of the development of our sewage treatment works and in fact ahead of our technology in some respects. As industry has increased, we find ourselves with a need to know how to take care of many of the new industrial chemicals and detritus from chemical processes that are being discharged into our streams.

Representative HOLIFIELD. In other words, if we face the problem squarely and look at it as it is, we find that streams all over the Nation are being polluted, such as the Potomac, right here in our own city of Washington, by all types of raw sewage and chemical effluent of a deleterious nature.

Throughout the length and breadth of America, the streams are being polluted to the point where that is rapidly becoming one of our great problems in our water supply.

Dr. PRICE. That is correct, sir.

Representative HOLIFIELD. And this is because the States in the main have failed, not all of them, but some of the States at least, to live up to their own responsibility in the protection of the purity of our streams.

Dr. PRICE. There are many States that have excellent programs in water pollution control.

Representative HOLIFIELD. But the State right above them on the tributary may not have; and therefore their program becomes, you might say, of no effect, because of a sister State that does not discharge its responsibilities as fully.

Dr. PRICE. There is a great deal of variation in their activity, and unfortunately there is a great lack of technology to be applied in ridding our streams of many of the industrial wastes.

Chairman DURHAM. Would the gentleman yield?

Doctor, looking at the future picture that Public Health will play in this field, and I do feel it is going to be an important one, and with the program you have developed, of course, over the years, which has been a good one, also, in my opinion, in cooperating with the States, in trying to protect the public health, and at the present time, with the authority that you have, how are you going to approach what I feel is going to have to be the point that Mr. Holifield touched on? Instead of getting into some State not carrying out its responsibilities and another one carrying out its responsibilities, can you work out a model law, some means whereby we will not have a checkerboard operation? Have you authority at the present time, do you think, to carry out such a duty?

Dr. PRICE. One of the responsibilities or authorities which the Public Health Service has under the Water Pollution Control Act is to study the water pollution control laws of the several States and to make recommendations to the States concerning their improvement.

Chairman DURHAM. This is going to go beyond the water pollution, I think. There are other hazards as to which the public expects some agency of the Government, either Federal or State, to provide protection.

Dr. PRICE. At the present time, the Public Health Service does not have any specific authority to work with the States in developing regulations related to all aspects of radiation.

Chairman DURHAM. Has your Department had any meetings with the States trying to codify this thing into a law that will have some similarity throughout the country?

Dr. PRICE. No, sir. We have not had meetings with the States for this purpose.

Chairman DURHAM. Well, do you feel it to be your responsibility to do that?

Dr. PRICE. I am not sure, sir, that I could say we have a clear statutory responsibility at the present time to do this. On the other hand, I feel that we could apply our general authority to work with the States to achieve better programs, and I think in this field perhaps one could do a similar thing to what we did many years ago in work-

ing out the standard milk ordinance and code, in which we had no specific authority, but we were able to be a focal point around which the best thinking on the subject in the country could crystalize.

Chairman DURHAM. Of course, your agency does have a large amount of information, which, of course, is available, and some agency has got to, in my opinion, take the lead in this thing in some way.

Dr. PRICE. This is the kind of thing which we would like to be able to do, as our program grows—and I feel confident that it will—we would like to work with the States to attain it.

Chairman DURHAM. Of course, at the present time several States have already adopted some form of laws, and others, of course, will consider it this year when their legislative bodies are in session.

I am just thinking that we might begin to think seriously that we have a problem here that we have got to solve; and the American public, I think, look to Public Health as one of the top agencies to protect them.

Dr. PRICE. We have done a few things in the past. For example, in the radiation field, there is our work with the States to secure the outlawing of fluoroscopic shoe fitting machines. This is something that we found the States able to do under their existing statutory authorities, and it was a matter of education and stimulation to achieve it.

Chairman DURHAM. Do you have a committee that works closely with the AEC in trying to get all the information you possibly can and have it available in your agency?

Dr. PRICE. We do not have a committee, but the various members of our staff in the Division of Radiological Health and many of the scientific workers in the Robert A. Taft Sanitary Engineering Center and the National Institutes of Health have almost day-to-day contacts with counterparts in the Atomic Energy Commission, so that I think there is an excellent flow of information and exchange of ideas.

Chairman DURHAM. I feel, of course, as Mr. Holifield, the chairman, has stated, that under the present circumstances you have done an excellent job in protecting the public; but I think it is going to have to be broadened out so that the States will have some responsibility.

Dr. PRICE. We agree fully with the sentiments that were expressed here this morning by Mr. Harold Price with respect to the importance of some consistency in the regulations as they are developed from place to place, because we recognize that it would be a serious handicap to developing industry here to have the capricious adoption of standards that vary widely from place to place.

Chairman DURHAM. It could happen that, of course, a local community or city, which has its own health laws or standards or regulations, might get into this field. So I think it would be much better if you could operate as you do today, in cooperation with the States, where we have a county health unit in every county in my State. And it is one of the greatest things we have ever had.

Dr. PRICE. It seems to us that, as the health profession and the public health workers become more familiar with this problem of radiation, there is going to be constantly a greater and greater meeting of minds as to what these standards should be and how they should be applied.

Chairman DURHAM. It is a big problem.

Representative HOLIFIELD. It seems to me that it is not too early for formalization of a study between representatives of the Atomic Energy Commission and the Public Health Service, probably under the appointment of Surgeon General Burney and Mr. McCone, to start studying this problem of joint responsibility and eventually transferral of responsibility, not only from the Atomic Energy Commission to the Public Health Service, to assist the Federal agencies, but also the further transferral of responsibility to the States. This might involve closer working with the Governors' council or such other bodies as might be selected by the States; that is in order that we might start working out some of these problems.

We are going to have hearings later in the year along the line of trying to study the types of legislation that are being offered, and with the hope that we can offer something in the way of information at least to these people in the States that are looking for guidance and looking for help.

I have talked to some of these people personally, and they are quite uninformed on this subject; naturally so, because it is a new development, and it is posing a lot of problems with which they are not familiar. But, as these installations come into their respective States, they are going to have to become familiar with it under their own State responsibility. And, of course, I think we have to maintain, as a committee, and as the Commission, our interest, to be sure that through lack of interest, or through lethargy, or lack of appropriations, a hazard does not come about in the State as a result of a reactor being built.

And, while I recognize you have no authority to go in and tell a State to do this or this, neither do we, as a Federal body. Certainly within the Federal statute which places custody and ownership and the public responsibility for protection in the Atomic Energy Commission, we could go so far as to exercise our responsibility by promulgation of such regulations and requests for compliance or demands for compliance, as will give to those people the protection which they need.

And I would be in favor personally of carrying this responsibility to the point of denying the shipment of these materials into States which will not or cannot protect their people from these materials of such great hazard.

I think that we do have this type of control, that we can deny the shipment into States or the building or the licensing of reactors into States which will not assume their share of the interstate responsibility, which in the last analysis I think we are going to have to assume.

Are there any further questions of Dr. Price?

If not, thank you, Dr. Price, for your statement.

Representative HOLIFIELD. Our next witness is from the Illinois State Department of Health, Mr. C. W. Klassen.

We will be pleased to have your testimony, Mr. Klassen.

I notice you have a long statement here, and this statement is too long for the time that we have, so we are going to accept this statement as part of the printed record.

If you can possibly summarize this by taking your subheads and going from subhead to subhead on it, we would appreciate it, at this time.

STATEMENT OF CLARENCE W. KLASSEN,[3] CHIEF, SANITARY ENGINEER, ILLINOIS DEPARTMENT OF PUBLIC HEALTH AND TECHNICAL SECRETARY, ILLINOIS SANITARY WATER BOARD

Mr. KLASSEN. I, sir, was going to ask that permission of you, to condense this, in the interest of time.

Representative HOLIFIELD. I might say for the benefit of the audience that Mr. Klassen is the chief sanitary engineer of the Illinois Department of Public Health and technical secretary of the Illinois Sanitary Water Board.

Go ahead, Mr. Klassen.

Mr. KLASSEN. Just a brief word about the phase of public health in which I am engaged. The practice of what we today call public health is founded on two basic services to the public. Personal hea'th services are those directed toward the individual, and environmental health services are those relating to the environment. This latter field encompasses seven major activities, including water, food, air, shelter, wastes, the control of natural hazards, and the control of manmade hazards. It is this field to which I will direct my testimony and discussion.

In Illinois, as in most States, the basic legal and the moral responsibility for the protection of the environment rests with the State. We know from our Illinois experiences that the people look to their State health department for the assurance that their environment is and will be adequately protected against any potential hazards resulting from any manmade activities, including those of the atomic energy industry.

On the other hand, I feel that the official activities of several State governments, and certainly Illinois, have been inspired for the most part by the Federal policy inaugurated by the Atomic Energy Act of 1954, of encouraging the public and private interests of the country to participate in the program for developing an atomic energy industry for peaceful uses.

Uncertainty, however, concerning the ultimate dimensions of this new industry and the relative positions of the Federal and State Gov-

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[3] Native of Grand Rapids, Mich.; graduate of University of Michigan in engineering (specialized in sanitary engineering).

Chief sanitary engineer, Illinois State Department of Public Health, and technical secretary, State sanitary water board. Responsible for the Department's activities in environmental health.

Also serves as (1) assistant professor of precventive medicine, University of Illinois College of Medicine (lecturer); (2) consultant to Atomic Energy Commission on radioactive waste disposal; (3) sanitary engineering consultant to World Health Organization of United Nations, having served as a consultant in Hawaii, in Japan to the Japanese Central Government, Formosa for the Chinese Nationalist Government, and in Hong Kong, North Borneo, Sarawak, and Jordan for the British Colonial Service, also in Siam, the Philippines, Greece, and European countries; has made two round-the-world trips as a consultant.

Major, U.S. Army (Sanitary Engineering Corps), World War II, in charge of procurement and assignment of sanitary engineers for all of the Armed Forces; chief sanitary engineer, commanding general staff, Eighth Service Command; awarded Army Coomendation Ribbon.

Organizations: American Public Health Association, member of executive council and chairman of committee on policy and legislation; National Sanitation Foundation (University of Michigan), vice chairman, council of consultants; National Society of Professional Engineers, member of military committee; National Research Council, Committee on Biological Effects of Radiation; member of American Water Works Association; Federation of Sewage and Industrial Wastes Association; Inter-American Association of Sanitary Engineers; American Chemical Society; American Society of Corrosion Engineers; Illinois section, American Water Works Association, past chairman; Illinois State Chamber of Commerce, member of water resources committee; past member of Cook County Planning Commission; Illinois Society of Professional Engineers, past chairman; Ohio River Valley Water Sanitation Commission, represents Illinois and served as chairman; member, executive board, Springfield United Community Service.

ernments in respect to its regulations have, I feel, precluded extensive State-level experimentation in fields other than the control of the radiation hazard to human health.

And then a very brief comment on our Illinois potential hazards as we see them, in the following categories: Under administrative and technical problems (1) the atomic energy installations, (2) off-Commission uses such as reactors in private powerplant development, reactors in research institutions, uses of isotopes in hospital and in industries, and (3) shipments of radioactive materials into or through the State.

In Illinois at the present time we have all of these points of concern. We are concerned with the discharge of materials into (1) Illinois watercourses, with resulting effects on water supplies, recreation, fish and aquatic life, and agriculture, (2) underground waters, (3) public sewerage systems, (4) the soil, (5) the atmosphere, (6) public highways, buildings, and other such phases of the environment through accidents involving radiation material, and (7) the potential uptake in the biological or plant life.

Then a very brief mention here of our Illinois water-pollution law, which we feel is adequate to cope with the present problems.

The State health department has been administering a registration act and a legislative commission in Illinois since 1955, devoted to the continuous study of these problems.

A general statement on the Illinois Atomic Energy Commission and AEC-contractor relationships: Relationships between a State and the Atomic Energy Commission or its contractors can exist merely on paper, be theeoretical with some high sounding and often meaningless phrases of cooperation, or it can exist strictly from a practical standpoint.

In this testimony, I choose to base what I say on some practical experiences that we have had in the State of Illinois with the atomic energy industry involving both the Atomic Energy Commission itself and its contractors.

Incidentally, this testimony includes all experiences and not just a selected few. I do not believe that these experiences in this testimony are primarily significant only so far as Illinois is concerned, for in our State there is nothing peculiarly different in our State department of public health or the sanitary water board from other States, nor should there be in the atomic energy industry's operation. I believe that they are both quite typical of what can, will, or at least should be found the country over. One primary difference, perhaps, is the fact that most of the administrative principles and practices in Illinois have really worked to the mutual advantage of the State and the industry.

Then a brief summary in the testimony, here, of Illinois background and our interest in the radiation field.

A few details of our actual experiences:

Argonne National Laboratory, a University of Chicago contractor: Early in the design of this utility (1947), contacts and a working relationship were established with the architect-engineers, Ford, Bacon, and Davis, relative to the environmental requirements, especially those referring to liquid wastes. At the same time, our available information was given concerning the development of water supplies and

domestic waste facilities. These early contacts have resulted in a close working relationship with the designing engineers and resulted in the furnishing, the construction, of adequate facilities for the treatment of domestic sewage and subsequently for facilities for handling the liquid wastes.

Numerous visits have been made by the witness to this installation. By this means, adjacent municipalities through their organized health agencies were kept advised by the State agencies that the environment was being properly protected against the discharge of potentially hazardous solid, liquid, and gaseous material.

Current activities involve the routine interchange of environmental monitoring data and assistance from the Argonne National Laboratory consisting of specific isotope analyses in our investigations in various parts of the State of suspected ground water contamination.

I can state, unequivocally, that from our standpoint we could ask for no finer and closer cooperation than we have received from those responsible for the construction and operation of the Argonne National Laboratory, and we feel that our relationships have been mutually characterized by commonsense and a practical approach to the environmental problems involved at that installation.

The testimony, then, relates some activities in the Ohio River Valley and the visit on invitation from the Atomic Energy Commission of this witness to several installations in the Ohio River Valley involving radioactive waste treatment, because Illinois is on the receiving end of all waste in the Ohio River.

My reactions and comments in all cases were favorable to the efforts and objectives of the Atomic Energy Commission and its contractors in protecting the environment, especially the outlet watercourses, from materials that would involve potential hazards.

Considerable of the information received from these various installations in the Ohio River Valley were also applicable and useful in the State of Illinois.

The Spoon River project, part of the AEC weapons program:

Immediately following the public announcement, early in 1953, of the proposed AEC Spoon River plant in Illinois, conferences were held with the Fluor Corp., designing engineers, and representatives from the AEC Santa Fe operations office. Outlet stream requirements were established, and the facilities for handling of the plant wastes were reviewed. At this time there was also an exchange of our information concerning the quality of the outlet watercourses for use as a water supply for the project.

Contacts with AEC included a visit to Los Alamos, N. Mex., by the witness to observe a pilot-production plant in operation, to observe the characteristics of the wastes involved and the result of studies that were being conducted on these wastes.

Then followed a series of conferences with the Fluor Corp., the Atomic Energy Commission representatives, and even though this facility was not completed and operated, the design and operation of waste-collection and disposal facilities had been thoroughly reviewed and approved by the State of Illinois.

In this particular instance, because this plant was generally known to be part of the weapons program, there was considerable apprehension among the local citizens, sportsmen, and agricultural inter-

ests concerning the effects on the streams of any wastes from this installation. Thus, it was a distinct advantage for our State sanitary water board to be able to answer intelligently some of the questions raised by these groups, to be able to advise the citizens that full cooperation was being received from the Atomic Energy Commission, and to give the assurance that the environment would not be affected in a manner detrimental to their interests.

In order to assure that all such public press releases were accurate, within classified regulations, and mutually satisfactory, a working arrangement was established whereby public statements relating to plant wastes, issued either by the local management of the plant or by the State department of health, were first mutually reviewed and approved prior to release. From a public relations standpoint, this paid good dividends, for it constantly reminded the local citizens that their own State agency responsible for the protection of their health and environment was interested in and fully aware of the plant developments and could, therefore, evaluate any environmental hazards that might apply to that community.

Representative HOLIFIELD. I might say that type of assurance to your local people from your local State health board is a great deal more valuable than if it came, let us say, from a Federal source, because people naturally have more confidence, whether it is justified or not, in people that are closer to them, and are more intimate with their particular and specific problems.

Mr. KLASSEN. That has been our experience.

Representative HOLIFIELD. I think the way that you people handled that in Illinois has been a very fine way to handle it.

Mr. KLASSEN. Then follows here the point that your witness has accompanied site review teams in anticipation of the site selection in Illinois of AEC installations, at which time we furnished data as to the requirements, the water potential, and likewise received information on potential characteristics and volumes of the waste.

Another instance given here in detail, which I will only mention, was in connection with a fuel-elements plant proposed near Chicago, when, in August 1955, we were advised by the Atomic Energy Commission that an application had been filed with the Commission. It subsequently followed that we met with the company, went over their project, and had full assurance that the environment would be protected.

It does serve as another example of the working relationship between our State departments, the AEC, and its contractors, a relationship, incidentally, that started at the first indication of such a proposed project.

Another instance: A uranium hexafluoride plant, General Chemical Division of Allied Chemical Corp., early in March 1957. The company officials notified the Illinois sanitary water board of their intent to apply for the required Illinois sanitary water board permit for treated domestic and radioactive waste disposal into the outlet stream, the Ohio River.

There subsequently followed conferences, with the result that we issued our permit for the domestic wastes in July 1958, and several days ago the board issued its permit for the radioactive waste disposal facilities.

We have in operation, with the full knowledge and cooperation of the company, an air monitoring station in that location.

The Dresden nuclear power station, Commonwealth Edison Co., owner and operator: Now under construction in Illinois is the Dresden nuclear power station, the largest nuclear powerplant in this country, rated at 180,000 kilowatts.

From a water resources standpoint, its location is important, being situated at the confluence of the Des Plaines and Kankakee Rivers where they form the Illinois River, whose basin drains one-half the area of the State of Illinois.

This again is given in detail. It merely, again, emphasizes the fact that immediately following the public announcement of this project in June 1955, a conference was held with officials of Commonwealth Edison Co. and General Electric Co., the prime contractors, to make known the environmental interests of the State of Illinois.

We have monitored the streams in that area and furnished the information to the company through AEC, and your witness visited the reactor at Shippingport early in its construction to secure general information concerning that installation, even though it was not of the same type.

The Bechtel Corp., the construction engineers for Dresden, have worked very closely with our State agencies. The witness, through the activities of General Electric, Commonwealth Edison, and AEC, attended demonstrations of General Electric's 5,000-kilowatt testing reactor and associated facilities in San Jose and Vallecitos, Calif., to evaluate the health and safety features to be incorporated in the Dresden design.

The sanitary water board issued its permit in March 1958, for the radioactive waste treatment facilities, having previously issued one for the domestic sewage.

I merely want to mention one as an excellent example of the close working relationship between the company and AEC, the rather unprecedented manner in which the permit and its conditions were prepared for radioactive waste disposal. This permit, the first of its kind ever to be issued by a State agency for this type of reactor power station, was prepared and all of the conditions agreed upon at a joint conference of the technical staffs of the State agencies and the industry. This resulted in a practical and mutually satisfactory document.

In the opinion of your witness, I feel that there is left little room for any suggested improvement in this particular instance with our relationships, so far as the AEC, its contractors, and the State of Illinois agencies are concerned.

Next the testimony details some actual experiences with radioactive isotopes. We have 300 active isotope users in Illinois.

We receive copies of all AEC licenses as they are issued to isotope users. We are informed of all proposed AEC inspections, and are invited to accompany the representatives, and in a majority of cases this takes place.

Next the testimony lists some six or seven actual experiences that we have had with incidents involving potential hazards to the environment, where we were immediately notified by AEC, one involving the theft of some radium needles. Six months afterwards, it turned up on the counter of a store in Chicago. The Argonne Laboratory was

notified, took custody, determined it was radium that was not licensed by AEC, notified the State health department, and we took custody and notified the manufacturers for eventual judgment.

Incidentally, the thief and unidentified customer that left them there was never found.

Several experiences: A list of short courses and seminars in which your witness has participated that were sponsored by AEC to show the close working relationship; another instance of working with an AEC contractor in Northwestern University and dosing the sanitary and ship canal near Chicago to determine the fate of fission products in watercourses; and the AEC Health and Safety Division, our relationship with them in utilizing their team, in the case of activities or incidents involving accidents and radioactive material.

Conclusions: From our Illinois experiences with the Atomic Energy Commission and its contractors, particularly in regard to radioactive waste disposal, it has been apparent that they have made every effort to prevent hazardous conditions from developing in the environment.

While a large measure of the satisfactory relationship that Illinois has mutually enjoyed with the AEC has been due to the administrative and technical attitude of the Commission and its contractors, I feel that of equal importance has been the attitudes and policy of the State of Illinois.

The following are some of these reasons, not necessarily in the order of their priority:

(1) The State administration has not avoided assuming a direct responsibility in this field. It is felt that any abdication of such a State's responsibility could not be made without jeopardizing the health and well-being of the citizens of Illinois.

(2) There has been no reluctance on the part of the State department of public health or the sanitary water board to accept its administrative and technical responsibilities for the protection of the environment. This was accomplished in spite of the early obstacles of the security aspects, the esoteric nature of the phenomena, and the semantic problem.

(3) The responsible agencies of Illinois government have made a deliberate attempt to foster good relationships, without compromising on responsibilities, so that subsequently other parties and firms have not been and will not be reluctant to contact these State agencies.

(4) We have followed a policy calling for early establishment and the maintaining of contact with the AEC and its contractors or designing engineers, as well as a free exchange of information regarding local environmental requirements in addition to information concerning the problems of the facilities.

(5) There exists a mutual appreciation, both technically and administratively, of each other's objectives, problems, and responsibilities.

(6) All concerned have accepted the mutual realization that there must be a practical and realistic approach and a commonsense attitude to these problems of waste disposal in order to prevent this vital atomic energy industry from reaching the brink of "being economically purified out of business."

(7) The existence since 1955 of a legislative commission which has continued studies, including the legislative needs of the problems of the atomic energy industry's development in Illinois.

And, finally, apparently both the State of Illinois and the atomic energy industry were and are convinced of the need for the above relationships.

It is the opinion of your witness that with this type of understanding, many of the mutual problems that arise will melt into an easy administrative solution and likewise encourage many practical technical advances.

I hope that my part of this discussion and testimony has emphasized and illustrated that a State can discharge its legal and moral obligations in this field of radioactive-waste disposal and can, with the AEC and its contractors, pursue a sound, economical, and practical approach to these problems of this new and vitally important industry.

Representative HOLIFIELD. Thank you very much, Mr. Klassen, for your testimony. It is very interesting, including the part that you had to skip because of the time. I assure you it was not a request on the part of the Chair because of the lack of importance of your testimony, because you have certainly outlined in your testimony a remarkable record of cooperation with the AEC and with the industry people in your area. I hope that all the States will be just as alert in discharging their State responsibilities as you people apparently have been.

Are there any further questions?

(Mr. Klassen's formal statement follows:)

STATEMENT OF CLARENCE W. KLASSEN, CHIEF SANITARY ENGINEER, ILLINOIS DEPARTMENT OF PUBLIC HEALTH AND TECHNICAL SECRETARY, ILLINOIS SANITARY WATER BOARD

(Concerning the Illinois State agencies relationships with the Atomic Energy Commission and its contractors in the construction of nuclear facilities in Illinois and the use of its isotopes in laboratories, hospitals, etc., with radioactive emphasis on waste-handling problems)

INTRODUCTION

The practice of what we today call public health is founded upon two basic services to the public, (1) personal health services or those directed toward the individual, and (2) environmental health services or those relating to the control of the environment. This latter field encompasses seven major activities including water, food, air, shelter, wastes, the control of natural hazards, and the control of manmade hazards It is in this field to which I will direct my discussion.

In Illinois, as in most States, the basic legal and the moral responsibility for the protection of the environment rests with the State. We know from our own Illinois experiences (and these have been duplicated the country over) that people look to their State health department for the assurance that their environment is and will be adequately protected against any potential hazards resulting from any manmade activities, including those of the atomic energy industry. On the other hand, I feel that the official activities of several State governments, and certainly Illinois, have been inspired for the most part by the Federal policy inaugurated by the Atomic Energy Act of 1954 of encouraging the public and private interests of the country to participate in the program for developing an atomic energy industry for peaceful uses. Uncertainty concerning the ultimate dimensions of this new industry and the relative positions of the Federal and State Governments in respect to its regulations have, I feel, precluded extensive State legislative experimentation in fields other than the control of the radiation hazard to human health.

ILLINOIS' POTENTIAL ENVIRONMENTAL HAZARDS

On the subject under discussion, the administrative and technical problems in Illinois are concerned with one or more of the following categories (1) The Atomic Energy Commission installations; (2) off-Commission uses such as re-

actors in private powerplant developments, reactors in research institutions, uses of isotopes in hospitals and in industries, and (3) shipments of radioactive materials into or through the State.

At the present time in Illinois, all of these possible sources exist and are points of concern. Hazards from an environmental health standpoint could be the escape of these materials into (1) Illinois watercourses with the resulting effect on water supplies, recreation, fish and aquatic life, and agriculture, (2) underground waters, (3) public sewerage systems, (4) the soil, (5) the atmosphere, (6) public highways, buildings, and other such phases of the environment through accidents involving radiation material, and (7) the potential uptake in the biological or plant life

Illinois has a water-pollution control law pertaining to surface and underground waters adequate to meet the problems involving radiological wastes. It considers these wastes as another industrial waste whose control activities must be absorbed in the routine of the sanitary water board's activities.

The State department of public health administers a law involving merely the registration and necessary investigation of all radiation sources and materials, but this includes no specific authority for control. It is anticipated this will be forthcoming in the present legislative session.

Illinois likewise has had since 1955 a legislative commission devoted to the continuous study of problems concerned with the peaceful uses of atomic energy.

GENERAL ILLINOIS AEC AND AEC-CONTRACTOR RELATIONSHIPS

Relationships between a State and the Atomic Energy Commission or its contractors can exist merely on paper, be theoretical with some high sounding and often meaningless phrases of cooperation, or it can exist strictly from a practical standpoint. In this discussion, I choose to base what I say on some practical experiences that we have had in the State of Illinois with the atomic energy industry involving both the Atomic Energy Commission itself and its contractors. Incidentally, this testimony includes all experiences and not just a selected few. I do not believe that these experiences are primarily significant only so far as Illinois is concerned for in our State there is nothing peculiarly different in our State department of public health or the sanitary water board (which is our stream-pollution control agency) from other major States nor should there be in the atomic energy industries operation. I believe that they are both quite typical of what can, will, or at least should be found the country over. One primary difference perhaps is the fact that most of the administrative principles and practices in Illinois have really worked to the mutual advantage of the State and the industry. Obviously, as in other new fields of environmental control, activities are often justified and based upon a State's problem in that particular field. Often, too, a State's interest and its administrative policies are greatly influenced by the background of events. Thus a very brief review of Illinois' background in the field of atomic energy is given only to better evaluate the problems and especially our administrative concepts. In some respects, however, Illinois does occupy a unique position among States in the field of atomic energy and its application. Historically and particularly significant is the simple bronze plaque on the west stand of Stagg Field, the old University of Chicago football stadium, which reads "On December 2, 1942, men achieved here the first sustaining chain reaction and thereby initiated the controlled release of nuclear energy." This was followed by the establishment of the metallurgical laboratories near Chicago during the early part of World War II and later by its successor, the Argonne National Laboratory.

DETAILS OF ILLINOIS EXPERIENCES

Argonne National Laboratory (University of Chicago contractor)

Early in the design of this utility (1947) contacts and a working relationship were established with the architect-engineers (Ford, Bacon & Davis) relative to the environmental requirements, especially those referring to liquid wastes. At the same time our available technical information in connection with the development of the water supply and the domestic waste-treatment facilities was offered. These early contacts resulted in a close initial working relationship between the State agency and the designing engineers. One result, for example, was the construction of temporary domestic waste-treatment facilities pending the completion of the final installation. Ultimately complete adequate treatment facilities were constructed for all of the domestic wastes and for treatment

of radioactive wastes that were to be discharged to the Illinois watercourse. Subsequently, through personal visits and those of qualified staff members, our State agencies have been kept assured of the operating vigilance of the Argonne National Laboratory not only in connection with its liquid waste-handling facilities, but also in the disposal of contaminated solids and the handling of its radioactive gaseous wastes. Numerous visits have been made by the witness to this installation. By this means, adjacent municipalities through their organized health agencies were kept advised by the State agencies that the environment was being properly protected against the discharge of potentially hazardous solid, liquid, and gaseous material. Current activities involve the routine interchange of environmental monitoring data and assistance from Argonne National Laboratory consisting of specific isotope analyses in our investigations of suspected ground-water contamination.

I can state unequivocally that from our standpoint we could ask for no finer and closer cooperation than we have received from those responsible for the construction and operation of the Argonne National Laboratory and we feel that our relationships have been mutually characterized by commonsense and a practical approach to the environmental problems involved at that installation.

Activities in the Ohio River Valley

Because of the concern and interest of the Ohio River Valley Water Sanitation Commission on the impact of AEC facility development in the Ohio River Valley, especially as they may relate to contamination of the Ohio River and its tributaries by radioactive and toxic wastes, and because Illinois is one of the signatory States to this compact and is on the so-called receiving end of all wastes in the Ohio River Valley, an invitation from the Atomic Energy Commission was accepted by the witness in 1953 to visit several AEC and contractor installation to observe the waste-treatment and handling facilities. These included the Mound Laboratory at Miamisburg, Ohio; ANP project at Lockland, Ohio; Feed Materials Plant, Fernald, Ohio; Heavy Water Plant, Dana, Ind.; and the Gaseous Diffusion Plant at Paducah, Ky. Representatives of AEC and its contractors at each of these installations presented information as to the character and type of wastes produced, the methods and facilities used for decontamination, the standards followed as to levels of activity in effluent release, and the monitoring and control methods used in evaluating results, both onsite and in the environs of the plant. My reactions and comments were in all cases favorable to the efforts and objectives of the AEC and these contractors in protecting the environment, especially the outlet watercourses, from materials that would involve potential hazards. Considerable of the information received was also applicable and useful in the State of Illinois projects.

Spoon River project (AEC weapons program)

Immediately following the public announcement early in 1953 of the proposed AEC Spoon River plant in Illinois, conferences were held with the Fluor Corp. designing engineers and representatives from the AEC Santa Fe operations office. Outlet stream requirements were established and the facilities for handling plant wastes were reviewed. At this time there was also an exchange of our information concerning the quality of the watercourse and its use as the water supply for the project. Contracts with AEC included a visit to Los Alamos, N. Mex., to observe a pilot-production plant in operation, to observe the characteristics of the wastes involved and the result of studies that were being conducted on these wastes. All this served as an aid in evaluating their effect on the particular Illinois stream in question. Conferences were also held in the offices of the Santa Fe operations in Albuquerque, N. Mex. Again in this instance, full cooperation was received from the AEC and Fluor Corp., designing engineers, and even though construction on this plant was not completed and operated, the design and operation of waste-collection and disposal facilities had been thoroughly reviewed and approved by the State of Illinois. In this particular instance, because this plant was generally known to be part of the weapons program, there was considerable apprehension among the local citizens, sportsmen and agricultural agencies concerning the effect on the streams of any wastes from this installation. Thus, it was a distinct advantage for our State sanitary water board to be able to answer intelligently some of the questions raised by these groups, to be able to advise the citizens that full cooperation was being received from the Atomic Energy Commission and to give the assurance that the environment would not be affected in a manner detrimental to their interests. In order to assure that all such public press releases were

accurate, within classified regulations, and mutually satisfactory, a working arrangement was established whereby public statements relating to plant wastes, issued either by the local management of the plant or the State department of Health, were first mutually reviewed and approved prior to release. From a public relations standpoint, this paid good dividends for it constantly reminded the local citizens that their own State agency responsible for the protection of their health and environment was interested in and fully aware of the plant developments and could, therefore, evaluate any of the environmental hazards as they might apply to that community.

Accompanying site-selection team

In 1953, Illinois was being considered as a possible site for a major AEC installation (which incidentally did not materialize) and the witness was asked to serve as a member of an AEC site-review team. He accompanied AEC technical personnel to some of the Illinois sites under consideration. He was advised of potential volumes and character of wastes and he furnished the AEC information on the necessary stream requirements related to waste treatment and disposal in those particular areas. Information was also furnished concerning water supply sources for the projects.

Fuel elements plant—Cook Electric Co.

In August, 1955, we were advised by the Atomic Energy Commission that an application had been filed with the Commission indicating intention of an Illinois industry to engage in the fabrication of fuel elements. Immedate communications directed to the company based upon this information led to personal conferences and a thorough discussion of the interests of the department of health and the sanitary water board in the handling of waste material that would be discharged into the air, water, or soil. These discussions included not only technical personnel but also the medical director of the plant. Full cooperation was given to the department, including a definitely expressed interest by the industry, to avoid any environmental hazards. Due to later developments, however, the plans for this plant did not materialize and hence its construction has to date been postponed. It does, however, serve as another example of the working relationship between our State departments, AEC, and its contractors—a relationship that started at the first indication of such a proposed project.

Uranium hexafluoride plant.—General Chemical Division of Allied Chemical Corp., contractors: Early in March, 1957, company officials notified the Illinois Sanitary Water Board of their intent to apply for the required Illinois Sanitary Water Board permit for treated domestic and radioactive waste disposal into the outlet stream, the Ohio River. Subsequently, there were conferences between representatives of the sanitary water board, the industry, and the Ohio River Valley Water Sanitation Commission, an interstate agency of which Illinois is a signatory State. These contacts and conferences with the industry's technical personnel resulted in the issuance on July 2, 1958, of the Illinois Sanitary Water Board permit for domestic waste-treatment facilities. Inspections of the plant were made by our technical staff and conferences continued concerning the radioactive wastes. In January 1959, the board issued its permit for the radioactive waste disposal facilities. Also with the knowledge and cooperation of the industry, a State health department air-monitoring station is located in the area. This is to secure background information prior to the actual operation of the plant and all results are available to the company. Excellent cooperation has been received in all phases of our negotiations.

Dresden Nuclear Power Station.—Commonwealth Edison Co., owner and operator: Now under construction in Illinois is the Dresden Nuclear Power Station, the largest nuclear powerplant in this country, rated at 180,000 kilowatts. From a water resources standpoint, its location is important, being situated at the confluence of the Des Plaines and Kankakee Rivers, where they form the Illinois River whose basin drains one-half the area of the State of Illinois.

Immediately following the public announcement of this project in June 1955, a conference was held with officials of Commonwealth Edison Co. and General Electric Co. the prime contractor, to make known the environmental interests of the State of Illinois in this project. During this same month, the sanitary water board started its surveys to determine the radioactivity background counts in the Des Plaines, Kankakee, and Illinois Rivers. These were done with the cooperation of another AEC contractor, Northwestern University, and all results were made available to the Commonwealth Edison Co. Later that year, opportunity was afforded the witness by the AEC to visit the nuclear power station then

under construction at Shippingport, Pa., to secure a general idea of the sources and disposal potentialities of wastes from a nuclear power reactor. The Shippingport reactor, however, was not of the same type as Dresden. During 1955, the Bechtel Corp., construction engineers for the Dresden project, contacted the sanitary water board relative to domestic waste-treatment facilities. Throughout 1956, there were conferences, exchanges of correspondence and a program of monitoring of background radioactivity in the rivers adjoining the proposed site. A sanitary water board permit was issued to Commonwealth Edison Co. in April 1957, for the sanitary sewerage system and domestic treatment works. Also during that year, the witness and a staff member attended demonstrations of General Electric's 5,000-kilowatt testing reactor and associated facilities in San Jose and Vallecitos, Calif., to evaluate health and safety features to be incorporated in the Dresden design. In July of that year, the company made written application for a sanitary water board permit for the radioactive waste-disposal facilities. This subsequently led to several conferences and an exchange of correspondence which culminated in the sanitary water board issuing on March 17, 1958, its permit for the radioactive waste-treatment facilities. An excellent example of the close working relationship between the technical staff of the sanitary water board and the Commonwealth Edison Co. is illustrated by the unprecedented manner in which the permit with its many conditions was prepared. This permit, the first of its kind ever to be issued by a State agency for this type of reactor power station, was prepared and all of the conditions agreed upon at a joint conference of the technical staffs of the State agencies and the industry. This resulted in a practical and mutually satisfactory document. The waste-treatment facilities are now under construction. The company subsequently made application for registration of the first shipment of nuclear fuel received at the site, as required by the Illinois registration act applicable to radiation sources and machines and administered by the State health department. This registration certificate has been issued.

The State department of health has begun its atmospheric and ground water sampling program in this vicinity. The company has contracted with a commercial concern for an environmental monitoring program and is also operating some of its own monitoring stations. A free exchange of the results of these programs is part of the working relationship with this industry. Your witness can state that from the standpoint of the State department of health and the sanitary water board, our relations with the Commonwealth Edison Co., the General Electric Co., and the nuclear power group which is associated with the Dresden project and with the Atomic Energy Commission representatives have been and we expect them to continue to be mutually most satisfactory. In the opinion of your witness, there leaves little room for suggested improvement in these relationships so far as the Illinois State agencies are concerned.

Use of radioactive isotopes

In addition to the above activities involving major physical installations, the following are examples of AEC-Illinois relations concerning isotopes. Illinois has nearly 300 active users of isotopes who are licensed by the AEC.

AEC INSPECTION DIVISION

Illinois receives copies of all AEC licenses issued to isotope users. We are also informed of all proposed inspection visits to be made by AEC personnel to such isotope users in Illinois and are invited to accompany the AEC representatives. In the majority of cases such joint inspections are made. This excellent working relationship is further exemplified by an arrangement permitting our staff members to visit Oak Ridge, Tenn., to bring our initial isotope records up to date.

Any incidents or information of importance to Illinois concerning radioactive isotopes are promptly reported by AEC and special notification is given to our State authorities of incidents involving natural occurring isotopes (not within AEC jurisdiction). Examples of these are as follows:

On April 5, 1957, 6 radium needles, involving 70 milligrams of radium, valued at $1,000, stolen from a Dayton, Ohio, hospital were left on the counter at the Newark Electric Co. in Chicago by an unidentified customer. Radiation at package surface was found to be 4 roentgens per hour. Argonne National laboratory was notified by the company, took custody, determined it contained radium (which is not licensed by AEC) and notified the Illinois State health

department, who took custody, located the manufacturer and returned the sources for eventual insurance adjustment.

In November 1957, Argonne National Laboratory personnel purchased radiation instruments for personal use from the Newark Electric Co., Chicago. Calibration sources obtained with the instruments were found to be leaking and to contain exceptionally large amounts of isotope (radium). Argonne National Laboratory immediately notified the State health department; we contacted the suppliers (Nucleonic Corporation of America) who replied that instruments were obtained from U.S. Air Force surplus. Other than those sold to Argonne personnel, there had been no record kept of purchases and efforts to secure this information to date have not been successful.

On July 17, 1958, a one-curie polonium-beryllium neutron source (licensed under AEC) was lost in an oil well in southern Illinois at a depth of 985 feet. Recovery attempts failed, so the source was immobilized with concrete at the bottom of the well. Our contact with this situation was secured through the immediate reporting of the incident by the AEC to the State department of public healh.

On October 19, 1958, an incident reported by the AEC occurred at Galesburg Cottage Hospital. A radium needle broken during sterilization did not result in a contamination problem due to action by hospital personnel who kept the sterilizer containing the needle within a safe until it could be properly disposed of.

On July 28, 1958, another incident occurred which indicates the cooperation afforded by Argonne National Laboratory in radiological health matters. An aged female patient at the South Chicago Community Hospital removed radium needles from her body where they had been placed for medical treatment and deposited them in a wastebasket without the knowledge of hospital personnel. The contents of the wastebasket were collected and burned in a hospital incinerator. When the loss was discovered the incinerator ash was monitored by qualified personnel and sent to Argonne National Laboratory for disposal. The incinerator subsequently was decontaminated.

Other activities indicating the working relationship between the AEC, its contractors, and the State agencies include personnel training and administrative assistance. The witness, for example, participated in the following AEC-sponsored meetings, conferences, and short courses:

Waste disposal seminar: Washington, January 1949.

Seminar on air-cleaning and stack-gas problems: Los Alamos, N. Mex., September 1953.

Fourth annual AEC air-cleaning conference and stack-gas working committee: Argonne National Laboratory, November 1955.

Conference of State representatives relating to AEC licensing program called by AEC: Washington, July 1955.

Presentation of paper "Technical Administration Aspects of the Environmental Problems as Related to States" at the Joint Atomic Energy Commission, Public Health Service conference: Cincinnati, December 1955.

Still another activity worthy of note is the State's relation with Northwestern University, an AEC contractor. State agencies participated in two experiments in which the sanitary and ship canal near Chicago was dosed with tritium (hydrogen 3) and scandium 46. The object of the project was to determine the fate of fission products in watercourses. The State participated by furnishing personnel, boats, and equipment for sample collection. Northwestern University has reciprocated by making frequent analyses involving radioactive material for the State health department and sanitary water board prior to the time when these agencies were equipped to do this work.

AEC Health and Safety Division

Relationship with this agency with representatives located at the Argonne National Laboratory recently consisted of the AEC offer of the availability to Illinois of an emergency team in the event of accidents or incidents involving radioactive material. This offer was accepted by the Governor and briefings were given by AEC representatives to key personnel in the various State agencies having jurisdiction in this problem. The Governor's interest in such matters is noted by his action in notifying all officials of governmental and political subdivisions in Illinois of the availability of this emergency team in the event of accidents involving radiological material. A notification plan to be placed into action, if such incidents occur in Illinois, has been integrated with the State police radio network. Currently a short training course is being planned to be

given by AEC personnel to key personnel in the various State departments which might be involved in handling such incidents. Included are the Department of Health, the Division of Highways, Department of Aeronautics, Illinois National Guard, Commerce Commission, State Highway Police, State Fire Marshal, and the Civil Defense Agency. The witness is the chairman of the Interdepartment Committee on Radiation Accidents, the committee which coordinates State activities in the event of such incidents.

Other incidental activities include the participation of AEC health and safety personnel in programs conducted by various State organizations such as the Illinois Public Health Association.

CONCLUSIONS

From our Illinois experiences with the Atomic Energy Commission and its contractors, particularly in regard to radioactive waste disposal, it has been apparent that they have made every effort to prevent hazardous conditions from developing in the environment.

While a large measure of the satisfactory relationship that Illinois has mutually enjoyed with the AEC has been due to the administrative and technical attitude of the Commission and its contractors, I feel that of equal importance has been the attitudes and policies of the State of Illinois. The following are some of the reasons (not necessarily in the order of their priority) for this successful relationship:

(1) The State administration has not avoided assuming a direct responsibility in this field. It is felt that any abdication of such a State's responsibility could not be made without jeopardizing the health and well-being of the citizens of Illinois.

(2) There has been no reluctance on the part of the State department of public health or the sanitary water board to accept its administrative and technical responsibilities for the protection of the environment. This was accomplished in spite of the early obstacles of the security aspects, the esoteric nature of the phenomena, and the semantic problem.

(3) The responsible agencies of Illinois government have made a deliberate attempt to foster good relations (without compromising on responsibilities) so that subsequently other parties and firms have not been and will not be reluctant to contact such agencies.

(4) We have followed a policy calling for early establishment and the maintaining of contact with the AEC and its contractors or designing engineers as well as a free exchange of information regarding local environmental requirements in addition to information concerning the problems of the facilities.

(5) There exists a mutual appreciation, both technically and administratively, of each other's objectives, problems, and responsibilities.

(6) All concerned have accepted the mutual realization that there must be a practical and realistic approach and a commonsense attitude to these problems of waste disposal in order to prevent this vital atomic energy industry from reaching the brink of "being economically purified out of business."

(7) The existence since 1955 of a Legislative Commission which has continued studies including the legislative needs of the problems of the atomic energy industry's development in Illinois.

Apparently both the State of Illinois and the Atomic Energy industry were and are convinced of the need for the above relationships. It is the opinion of your witness that with this type of understanding many of the mutual problems that arise will melt into an easy administrative solution and likewise will encourage many practical technical advances.

I hope that my part of this discussion and testimony has emphasized and illustrated that a State can discharge its legal and moral obligations in this field of radioactive-waste disposal and can, with the AEC and its contractors, pursue a sound, economical, and a practical approach to these problems of this new and vitally important industry.

Representative HOLIFIELD. We will ask Dr. H. S. Ingraham, who is from the New York State Department of Health, to come forward.

Dr. Ingraham, we are glad to have you before us. You may proceed, if you will.

STATEMENT OF DR. HOLLIS S. INGRAHAM,[4] FIRST DEPUTY COMMISSIONER, NEW YORK STATE DEPARTMENT OF HEALTH

Dr. INGRAHAM. I would be very glad to summarize this, if you wish, Mr. Chairman.

Representative HOLIFIELD. All right.

Dr. INGRAHAM. I am Hollis Ingraham, the first deputy commissioner of the New York State Department of Health, where I work under Dr. Herman Hilleboe, the commissioner.

I am representing, therefore, the view of a State health department.

In summary, I might say that we regard human health as the central problem in radioactive waste disposal, and in view of the fact that the Federal Constitution gives an almost exclusive responsibility to the States in protecting the health of the citizens, we feel that it is necessary for States, and particularly working through the State health departments, to assume a greater area of responsibility than they have heretofore.

In our own State, we have been largely concerned during the last 4 years with the control of X-ray, since at the present time that is the radioactive problem which poses the greatest threat to human health and also which is most readily controllable.

There is now under construction in New York State a Consolidated Edison powerplant, and we are now turning with greater emphasis to the problems which the construction of large powerplants pose to the State health department.

We are convinced that we must take an active interest in this. In the first place, we have conducted an extensive radiation survey of the site. We believe that we must also be concerned with the potentialities in the case of disaster, and that we must give special attention to disaster planning in the event of an incident. We also expect to conduct routine inspections.

In our work so far in connection with waste disposal, which, as I say, we are merely beginning, except for extensive and statewide monitoring of air, water, milk, and precipitation, having concentrated on X-ray, we have had the fullest cooperation from the Atomic Energy Commission and from the Public Health Service.

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[4] Born in Brookline, Mass., March 10, 1908.

Harvard University: A.B. cum laude 1930; M.D. cum laude 1933; M.P.H. cum laude 1935. Interned at Plymouth County Tuberculosis Hospital, South Hansen, Mass., at United States Public Health Service Hospital, Staten Island, and at the Margaret Hague Maternity Hospital, Jersey City, N.J.

Joined the staff of the State Department of Health in 1934, advancing by steps as epidemiologist, district health officer, director of bureau of communicable diseases, deputy commissioner to present position.

Served in the United States Navy from 1942 to 1946 as lieutenant and lieutenant commander and subsequently promoted to commander. While in service, he received the medal of the American typhus commission.

He is a diplomate of the American Board of Preventive Medicine and Public Health, a Fellow of the American Medical Association and the American Public Health Association, a member of the American Epidemiological Society, the New York State Public Health Association, the Eastern Branch of the Society of American Bacteriologists, New York, the New York State Public Health Association, the Eastern Branch of the Society of American Bacteriologists, the Albany County Medical Society, the Medical Society of the State of New York, and the New York State Academy of Preventive Medicine.

Is a council member at large on the Fort Orange Council of Boy Scouts, on the executive committee of the board of directors of the Associated Hospital Service of the Capital District, and is chairman of the board of directors of Health Research, Inc. Is author of numerous articles published in medical journals, and is a member of Delta Omega, honorary public health fraternity, and of Alpha Omega Alpha, honorary medical fraternity. Is listed in Who's Who in America, Who's Who in New York, Who's Important in Medicine, and the Directory of Medical Specialists.

As far as the future is concerned, we expect to greatly expand our program of monitoring and of inspection of radioactive installations so as to be able to assure the people of the State that we are working closely with the Federal agencies in protecting their health.

We believe the time has come when there is need for a more clear-cut delineation of relative responsibilities as between the Atomic Energy Commission, the U.S. Public Health Service, and the States and local communities.

We believe particularly that the long pattern of cooperative effort in protecting the health of the citizens which has existed between the Public Health Service and the States should be extended into the field of radiological health protection. This, as you know, has consisted in grants-in-aid, the loaning of trained personnel, and consultation.

We would suggest that the Public Health Service repeat, in the field of radiological health, the pattern which they followed in venereal disease control and tuberculosis some years ago, in which there was literally a crash program, with the training of large numbers of persons, their loaning to the States, and with additional emphasis on the pattern of Public Health Service and State health department cooperation that has worked so well for so many years.

In concluding, I do wish to reiterate that we have received great assistance from the Atomic Energy Commission, from the U.S. Public Health Service, and also from other Federal agencies, including the U.S. Army, and Geological Survey and that we will continue both to need and to welcome help in this complex field.

As Dr. Wolman has pointed out, the magnitude of the problem calls for efforts at all levels of government and cannot best be solved by an exclusive delegation of authority to one level.

I wish to emphasize the State's very definite obligations which they should begin to assume in cooperation with the Federal Government.

Thank you.

Representative HOLIFIELD. Thank you very much.

Are there any questions of Dr. Ingraham?

Thank you, sir.

(Dr. Ingraham's formal statement follows:)

THE RESPONSIBILITY OF STATES IN THE DISPOSAL OF INDUSTRIAL RADIOACTIVE WASTES

By

Hollis S. Ingraham, M. D.
First Deputy Commissioner, New York State Department of Health

Human health is the central problem of radioactive waste disposal. Such wastes if allowed to contaminate air, water, vegetation and soil can become a major menace to health, in both an immediate physical and an ultimate genetic aspect.

Radioactive waste disposal has secondary implications that involve conservation, agriculture and commerce. Yet even these three fields bear some ultimate relationship to health since they affect the adequacy of living standards and good nutrition.

According to the Federal Constitution health is an almost exclusive responsibility of the states. This means that the disposal of radioactive wastes is a matter lying well within the purview of state authority. However, the development of atomic energy during World War II made it expedient to place the control of nuclear waste disposal in federal hands. The wartime emergency has passed and it is now time for a clear cut delineation of responsibility in control measures between federal agencies and state governments.

The threat of radioactive industrial wastes to human health makes it urgent for states to assume their constitutional responsibility to protect the well being of their citizens. Federally owned and operated plants which produce radioactive wastes should retain their responsibility for control. However, where such plants dump radioactive waste into state waters, soil or air, there is an impelling need for joint control measures to be developed.

The first step in the control of radioactive wastes is the enactment of laws or regulations which enable a branch of state government to act with effectiveness. In New York State, the Legislature has directed the State Health Department to "supervise and regulate the public health aspects of the use of ionizing radiation and the handling and disposal of radioactive wastes."

In accordance with this legislative authority, the Public Health Council of the State Health Department has enacted regulations in the Sanitary Code which spell out requirements for public protection against ionizing radiation.

Regulation 9 of the Code specifically provides that radioactive wastes shall not be disposed of by surface dumping or burial in soil except in areas approved by the State Commissioner of Health. This regulation also states that the State Commissioner of Health shall see to it that no producer of such wastes is permitted to discharge amounts which, when added to discharges from other sources, comprise a hazard to health.

The administration of these regulations requires the establishment of an operating control agency within a department of state government. The natural choice is the Health Department, which in most cases is already responsible for control of other forms of air and water pollution.

However, other state agencies also have an interest in the control of ionizing radiation and radioactive wastes. These include departments concerned with commerce, agriculture, labor and conservation. The answer to this interdepartmental concern is the establishment of an agency which coordinates the contributions of each department into an effective total effort.

In New York State, the Health Department has assumed responsibility for the general control of ionizing radiation, including waste disposal. The Department of Labor retains responsibility for the protection of the health of

workers in industry. The previous Governor appointed a joint commission on atomic energy which included representatives from all interested departments. The present Governor is considering legislation in this area.

Specific state responsibility for control of industrial radioactive waste disposal begins with the location of industrial nuclear installations. This means that the state must assume authority to approve the selection of a site for an installation. It seems likely that few states will plan to review design plans in detail, at least in the immediate future. The state agency must, of course, have sufficient information on the potential of the plant to determine the appropriateness of the site.

In our planning we must assume that human error will make accidents inevitable. How serious such accidents will be is a matter depending upon the distribution and density of population, the nature and extent of animal life, vegetation and water resources as well as the topography around the proposed installation, and the potential volume of accidental contamination the plant is capable of emitting.

To assess these factors and also to prepare for adequate monitoring, the control agency should undertake a pre-operational survey, in order to discover the natural amounts of radioactivity present around the proposed site. Without this estimate it would be impossible to measure abnormal contamination levels.

When operations begin, the state should maintain regular inspection of the plant operation and continuous monitoring of the surrounding environment for levels of radioactivity. The day-to-day volume of radioactive emissions into the air and into both surface and underground water are important measurements that should be conducted in close cooperation with the state agencies in charge of air and water pollution.

The primary consideration is the total load of atomic wastes from all sources that can be borne safely by the air and water resources of the state. A percentage of the maximum load of atomic wastes is already being utilized due to natural background radiation and fallout from atomic weapons testing. The development and expansion of the atomic energy industry in any community or state must consider the present and future potential for the disposal of solid, liquid and airborne radioactive wastes. Committing any or all of the states resources to receive and assimilate radioactive wastes from industry within a state should be a state's responsibility.

Whether or not each state should own and control a disposal site to dispose of excess radioactive wastes from installations is a matter for serious consideration in the near future.

The menacing implications of the haphazard disposal of waste substances on the health of the citizens of the future is such that the matter cannot be left to private initiative. It is manifestly undesirable to have many scattered disposal areas in some of which the titles might become obscured in the future and thus be subverted for other purposes.

The development of a disaster plan should have a high priority among those states with nuclear installations inside their borders. Many things need to be planned for if the effects of a disaster are to be minimized: Plant personnel and surrounding populations must be evacuated; rapid medical care of the injured needs to be provided; a prompt clean-up of contaminated areas needs to be initiated; the resources of other public and voluntary agencies should be marshalled for an integrated effort; intense monitoring of food-producing vegetation should be carried out and the persons who normally consume such foodstuffs need to be protected from exposure. A disaster plan must also provide for realistic and extensive drills.

This is an outline of our planning in New York State. We have begun to implement each of the steps suggested here, but are not yet in full operation partly because of a shortage of trained personnel.

In the field of radiological health protection our emphasis to date has centered far more on the X-ray hazard than on disposal of industrial radioactive wastes since, at present, X-ray offers a greater threat to health and is more easily controllable.

In preparation for further efforts in the control of atomic wastes we have initiated a program of monitoring of water, air, milk and precipitation. Over 1300 water samples have been analyzed in the last four years. Twelve air sampling stations have been established throughout the state and daily samples are checked for radioactivity. Five other stations sample dustfall and precipitation, and in five areas milk is tested for strontium 90 content by a new method developed in the Department of Health.

With assistance from the United States Public Health Service, the Atomic Energy Commission and the U.S. Army New York State has recently carried out an extensive radiation survey of the lower Hudson Drainage Basin. It is expected that by 1960 three nuclear reactors will be in operation in the area.

We, in New York State, have received full cooperation and assistance from the Atomic Energy Commission and from the United States Public Health Service in our early efforts. Other federal agencies including the U.S. Army and the U.S. Geological Survey have also given aid. Prior to the enactment of any regulations, the General Manager of the Schenectady Office of the Atomic Energy Commission appointed a Mohawk River Advisory Committee consisting of representatives of the State Health Department and one local representative. It was the purpose of this Mohawk River Advisory Committee to advise the Knolls Atomic Power Laboratory located in Schenectady County and the Atomic Energy

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Commission of the effect of radioactive waste discharges on the environment. This Committee meets routinely with representatives of the Atomic Energy Commission and General Electric Company, the Contractor - operator of KAPL facilities, to discuss and review any questions or problems of mutual interest and to establish agreement on levels of any environmental waste discharges.

Insofar as privately owned and operated nuclear facilities are concerned, the federal government has provided the state with notification of the proposed issuance of a construction permit.

The New York State health regulations require registration of certain specified amounts of radioactive materials. Workable arrangements have been established with the Atomic Energy Commission whereby the Health Department does receyve notification of licenses issued by the Atomic Energy Commission for the use of by-product material but does not exempt the licensee from registering under the Health Department regulations.

One other way in which New York State and the Atomic Energy Commission have cooperated is in the preliminary discussion of a ground burial facility for the disposal of radioactive wastes. A joint effort is desirable to establish uniform criteria and monitoring facilities for any common burial facility.

As the states assume their proper functions in radiological health protection, they will continue to need cooperation and assistance from the federal agencies. In recent years the federal government has been of great help to the states in the development of health programs through grants in aid, loan of trained personnel and consultation. We suggest that the United States Public Health Service should initiate a crash program of aid to the states in

radiological health such as it conducted with venereal disease and tuberculosis. Emphasis should be placed on recruitment and training, with the loan of such trained personnel to the states.

Since the United States Public Health Service is the federal agency having primary concern for health and has a long tradition of close cooperation with State Health Departments, we suggest this agency be assigned the federal responsibility for radioactive waste disposal.

In concluding I wish to reiterate that we have received great assistance from the Atomic Energy Commission and the United States Public Health Service and that we will continue both to need and to welcome help in this complex field. As Doctor Wolman has pointed out, the magnitude of the problem calls for efforts at all levels of government and cannot best be solved by an exclusive delegation of authority to one level. The states, however, have definite obligations which, in cooperation with the federal government, they should begin to assume as rapidly as circumstances will permit.

NEW YORK STATE DEPARTMENT OF HEALTH
BUREAU OF ENVIRONMENTAL SANITATION

RADIOLOGICAL HEALTH PROGRAM

The State Health Department's role in the field of radiological health is of recent origin and has been precipitated by the development and expansion of the atomic energy industry. It is recognized that the needless exposure of individuals to ionizing radiation may result in somatic and genetic effects which are cumulative and irreversible. Although the population exposure has existed for many years in the form of natural background and in the widespread use of equipment capable of producing ionizing radiation, the scientific findings in the last decade has shown that radiological health is an important Health Department Program and must be expanded to insure adequate protection of the population.

The rapid growth of the atomic energy industry, increasing use of X-ray in the healing arts and the stratospheric inventory of thousands of curies of radioelements, due to atomic weapons testing, depositing radioactive wastes daily in all parts of the world, necessitates a comprehensive Radiological Health Program. This program must include not only regulation, service and education with respect to existing and proposed radiation sources but also a surveillance program to determine the contribution of radioactivity to man through the media of air, food, water and milk.

I. ACTIVITIES AND PROGRAMS PRIOR TO 1958

Shortly after World War II, two Atomic Energy Commission facilities were developed in New York State and the State Health Department recognizing the potential radiation hazards which might occur provided training for two engineers in the technical aspects of the control of radioactive wastes so that there would be understanding and cooperation in the development of these facilities. Limited training of Health Department employees in various aspects of radiation continued during the subsequent years.

In 1952, one engineer in the Bureau of Sanitation in addition to his other duties, was directed to study and develop a Radiological Health and Air Pollution Program. The first regulation ever contained in the New York State Sanitary Code relating to the control of X-ray producing equipment was enacted in 1953. This regulation effective July 1, 1953 governed the operation of shoe-fitting fluoroscopes.

One Senior Sanitary Engineer position (Radiological Health and Air Pollution) was created in April 1954 and this engineer was assigned to the administrative section of the Bureau of Sanitation.

Following the enactment of regulations governing shoe-fitting fluoroscopes, it was decided that a complete study of the radiation problem in New York State should be made. The various uses of radiation were examined and the potential hazards evaluated. This study was completed in June of 1954, when a proposed radiation hazards control program plan was submitted to the State Commissioner of Health. This program plan established five objectives; namely, (1) to measure the average radiation exposure presently existing in the general environment, (2) to institute and apply measures to control ionizing radiation in the general environment to prevent the accidental and needless exposure of the public, (3) to institute and apply control measures so that radiation exposures among those handling radiation do not exceed the maximum permissible dosage, (4) to develop means for diagnosing radiation injuries and measuring their extent by the application of the combined skills and knowledge of the several scientific disciplines, (5) to keep informed on new developments in the application of radiation so as to be prepared to control new hazards which might be created.

A Technical Advisory Committee was appointed by the State Commissioner of Health representing technical and administrative groups and users of ionizing radiation. This Committee concluded that there already existed a significant radiation problem and that the State Health Department should initiate a program in the control of radiation hazards through education, regulation, inspection and enforcement.

In 1955, the Health Department sponsored legislation which amended Article 3 of the Public Health Law giving the Department the power of supervising and regulating the public health aspects of ionizing radiation and the handling and disposal of radioactive wastes. This enabling act and the quasi-legislative power of the Public Health Council resulted in the enactment of Chapter XVI of the New York State Sanitary Code entitled, "Ionizing Radiation" effective September 1, 1955.

This Sanitary Code regulation excludes those installations in commercial and industrial establishments which by tradition and by law are the responsibility of the New York State Department of Labor. The Department of Labor has enacted a complimentary code which governs occupational exposure occurring in industrial and commercial establishments. Environmental wastes discharged from such establishments are regulated by provisions contained in the Public Health Law and Sanitary Code.

The pertinent provisions of Chapter XVI of the New York State Sanitary Code are as follows:

1. Registration of all sources of ionizing radiation.

2. Establishing maximum levels of exposure.

3. Reporting of accidents, spills or over-exposure.

4. Regulating waste discharges.

5. Burial of radioactive materials.

6. Handling of cadavers previously treated with radioisotopes.

7. Monitoring of radiation installations.

8. Limiting application of radiation to humans.

9. General provisions relating to health and safety aspects of radiation installations.

In 1955, a separate Radiological Health and Air Pollution Section was established in the Bureau of Environmental Sanitation consisting of one senior and one assistant sanitary engineer position.

The following program was established:

1. Registration of sources of ionizing radiation as required by regulation.

2. Training of Health Department personnel through short in-service-training courses in different aspects of radiological health.

3. Inspection of radiation installations and consultation with operators of such installations.

4. Surveillance program for measuring radioactivity - air, water, dustfall and precipitation. This will be of immeasurable value in the future and must be expanded so that we are on firm ground in defining our "baseline".

5. An operational guide (Sanitation Manual) setting forth procedures to efficiently carry out the general program.

6. Technical assistance to local health departments.

7. Portable instruments were purchased including geiger counters, ionization chambers, dosimeters and other necessary survey equipment which was furnished to all District Health Offices.

II. PRESENT ACTIVITIES AND PROGRAM PLAN

The orderly development of a comprehensive Radiological Health Program is contingent upon many factors including reasonable legislation, personnel, equipment and cooperation from many departments of government and operators of radiation installations. The control of radiation

hazards to reduce or eliminate where possible unnecessary or needless exposure is a challenge to all health agencies which will be met through the support of all technical and lay groups.

A. Radiation Sources

1. Radiation Installation (X-Ray)

As of December 31, 1957, there were 4,953 X-ray installations (6,380 X-ray machines) including chiropractors and shoe-fitting fluoroscopes registered with local health departments. Excluding chiropractors and shoe-fitting fluoroscopes and making allowance for the fact that registrations are not complete in all local health units, it is estimated that there are 5,490 X-ray installations in 1958.

From Tables 1, 2 and 3, the present status of the Radiological Health Program is reflected as follows:

In 7 of the 13 District Offices over 50% of the X-ray installations will be inspected in 1958. In 6 of these 7 District Offices, seasonal personnel assigned on Radiological Health by the Bureau of Environmental Sanitation resulted in this accomplishment.

In 8 of the 20 County Health Departments over 50% of the X-ray installations will be inspected in 1958. In 7 of the 9 County Health Departments, personnel employed by the county completed these inspections.

In 4 of the 9 Full-time City Health Departments over 50% of the X-ray installations will be inspected in 1958. The City of Binghamton contracted for inspectional services and the other cities will complete these inspections by personnel employed by the City Health Department.

In Table 4, there has been tabulated the number of radiation installations in 1958 and the estimated number based upon a population increase in 1963.

The established frequency for inspection of X-ray installations is as follows:

(a) Three Year Intervals

a. Use of X-ray and teletherapy units in hospitals, diagnostic laboratories, educational institutions and other institutions exclusive of state institutions.

(b) Two Year Intervals

a. Use of X-ray in industrial and commercial establishments not subject to supervision by the New York State Department of Labor and any other installations where radiation is applied deliberately to a human.

b. Use of X-ray in teletherapy units in hospitals, diagnostic laboratories, educational institutions and other institutions exclusive of state institutions.

(c) One Year Interval

a. Use of X-ray in state institutions.

For program planning and in order to complete inspections of all units initially, a total of 12.4 man-years is needed. This is assuming 2 inspections per day and 220 working days per year. If these initial inspections can be completed, then following the established frequency of inspection as indicated above, an estimated 50% reduction by 1963 or approximately 6.6 man-years would be required to carry out the consultation and inspectional phase of this program.

Budgetary approval in the fiscal year 1959-1960 for summer employment of ten two-month positions as radiation inspector is necessary to give additional impetus in this phase of the program. It is planned to assign these inspectors to local health units based upon the needs of the unit. Experience in 1958 shows that this type of an approach has stimulated some local units to make plans for a Radiological Health Program.

The basic and instrumentation in-service-training courses given by the Health Department and additional field training given by the personnel of the Radiological Health Section has qualified personnel (routine inspections of X-ray units) in all but four of the local health units. The personnel in some units have received this training two or three years ago and have not been performing routine inspection of X-ray units and are, therefore, in need of a short two or three-day refresher course or field experience with a representative of the Radiological Health Section.

In addition to manpower needs for the inspectional phase of the program, regional or other staff personnel must provide continuing supervision, training and consultation to local units. The estimate of these needs for this part of the program are included in the summary.

B. Radioactive Materials Including Radioactive Isotopes and Naturally Occurring Radioactive Elements

In Table 5, there is listed the number of users of radioactive materials registered with local health departments as of December 31, 1957.

There is also included in this Table the location and type of all radioactive isotope users in New York State including New York City for the period from February 10 to May 31, 1958.

From Graph No. 1, there has been plotted the number of users of radioactive isotopes versus time. It will be noted that there was expansion in this field at an accelerated rate between 1951 and 1956 with a leveling off after 1957. It is difficult to predict the future growth but extrapolation of the curve to 1963 would indicate only a 10% increase. The total number of Chapter XVI installations would accordingly show an increase between 1958 and 1963 of 160 and 190 installations respectively.

It will be noted that there are 110 users of radioactive materials registered with local health departments and it is recognized that registrations are not complete. It is estimated that there are 160 such installations which should be registered with local health departments and an additional 75 installations which should be registered with the New York State Department of Labor and located in upstate New York.

At the present time, there have been few routine inspections of this type of installation by local health departments. This phase of the program is of considerable importance not only to evaluate hazards and determine compliance at the radiation installations, but also where unsealed sources are involved, to determine environmental effect of discharge of wastes. Therefore, in addition to installations which come under the provisions of the New York State Sanitary Code, the Health Department is concerned with all other installations which may produce or otherwise discharge wastes to the environment. It should be noted that the Atomic Energy Commission places the responsibility upon the licensee of meeting all applicable regulations, whereas the Health Departments as in other programs should provide for inspection, monitoring and where necessary approve plans for treatment and/or disposal of wastes.

The established frequency for inspection of these installations is as follows:

(a) Two Year Intervals

a. Use of radioactive materials in sealed sources.

b. Intrastate carriers of radioactive materials.

(b) One Year Interval

a. Use of radioactive materials in unsealed sources.

b. All sources of radioactive wastes from installations covered in Chapter XVI.

c. Use of radioactive materials in state institutions.

There is an immediate need for additional training of personnel in this phase of the program. A four-day in-service-training course is scheduled for December at the University of Rochester which will be devoted to isotopes and radioactive materials. Additional courses of this type will be necessary to provide the necessary training of personnel in local health units.

The services of competent consultants readily available to local health departments to plan, develop and train personnel must be provided. The budgetary approval of 5 senior sanitary engineers' positions for assignment to regional offices will meet this basic need.

In considering the problems, work load and number of installations, a conservative initial estimate of 3 man-years is necessary to carry out an effective program. This includes inspection of installations and evaluation of environmental hazards by local health units.

3. Particle Accelerators

The small number of particle accelerators located at educational or Atomic Energy Commission installations does not at present represent a large work load. Planning for inspection of such installations initially should be by staff personnel in cooperation with the local health department.

4. Nuclear Reactors

In Table 6, there is listed the nuclear reactors (power, research or training) which will be in operation in New York State. It is expected that five will be operating at the end of 1958 and nine or more in operation within the next two years.

Notwithstanding the possibility of an excursion, there is a varying degree of hazard associated with nuclear reactors with one criteria being the power level of operation. The Health Department has, therefore, undertaken a pre-operational survey in the vicinity of the Consolidated Edison Company nuclear power reactor in Westchester County. This survey is independent of the hazards study being made by the industry. In cooperation with local health departments and the Conservation Department, samples are being collected of water, soil, air, plankton and animal thyroid within a ten mile radius of the site. In September, a helicopter was made available to the department through the courtesy of the United States Military Academy and instruments for the aerial survey were provided by the Atomic Energy Commission. The aerial survey of the Lower Hudson Area in the vicinity of three proposed nuclear reactors established background gamma radiation. Development of different techniques to quickly and definitely establish high levels of radiation following an incident or excursion must be explored by the

Health Department. It is now planned to utilize the same instruments and make measurements along the road network in this same general area to compare background levels and the suitability and reliability of different techniques.

This particular phase of the program must be expanded and developed as follows.

a. To determine existing levels of radiation exposure in the general environment.

b. To find a good biological indicator or indicators which would reflect increases in radiation levels due to waste discharges.

c. To apply control measures so that the releases to the environment do not exceed permissible concentrations.

d. To provide a continuing and, if necessary, an expanded program to insure that all necessary controls are applied, i.e., routine monitoring, of one or more biological indicators.

The psychological value of assuring the public by continued detailed monitoring at the natural radiation levels will be as valuable in the long run as the development of a system to provide legal evidence against possible contamination.

Based upon existing commitments such as the pre-operational survey, the immediate need for establishing monitoring stations near reactors, evaluation of hazards at a reactor and review of plans for waste discharges the manpower needs are estimated as follows:

a. One full-time engineer to coordinate with existing local health departments the Consolidated Edison Company pre-operational survey program. This would include planning, mapping and compiling data on the different phases of this study.

b. One engineer to permit expansion of the nuclear reactor monitoring program at other installations throughout the state and including hazards evaluation and inspection of installations at routine intervals.

c. One engineer sufficiently trained or nuclear physicist as a consultant in all phases of nuclear reactor operations.

E. Disposal of Radioactive Wastes Burial Facilities

The extensive use of radioactive materials has resulted in a need for ground burial facilities. The industry and other users of radioactive materials are primarily concerned with the disposal of liquid and solid wastes which if not satisfactorily handled could be a hazard to succeeding generations. Under the provisions of the Sanitary Code, any ground burial facility for the disposal of such radioactive materials must be approved by the state commissioner of health. This will insure that all hydrological and meteorological factors will be considered as well as assurance of site monitoring.

B. RADIATION CONTROL ACTIVITIES

The surveillance activities of the Health Department include water, air, milk and food. The levels of radioactivity in these media are directly related to:

1. naturally occurring radioelements
2. fallout from atomic weapons testing
3. discharges from laboratories, hospitals and industries who use or produce radioactive materials

Health Department control measures can be applied to those sources as mentioned in Item 3. Knowledge of gross levels of radioactivity and the increase due to the different sources is important to effect any control program.

1. Water

The Division of Laboratories and Research has been analyzing samples from public water supplies throughout New York State to determine levels of background. The influence of man-made radioactivity due to atomic weapons testing is increasing intermittently the gross activity in surface water supplies. The total effect of waste discharges into surface streams is not completely known and a study is being undertaken by the Radiological Health Section to evaluate the effect on the Hudson-Mohawk River by surveying installations and providing for an increased sampling program. The present acceptable permissible concentration of radioactive contaminants in water is in addition to the natural background caused by man. In the application of present standards it is, therefore, necessary to consider man-made additions of radioactivity.

Fallout buckets which will integrate total fallout (dust and precipitation) for weekly periods are now located at Lockport, Syracuse, Albany and in the Lower Hudson Valley. Two additional fallout bucket stations are being established at Binghamton and Plattsburgh.

2. Air

The Division of Laboratories and Research has been collecting air particulates for determining gross beta activity. An additional thirteen sampling stations have been established by the Air Pollution Control Board throughout New York State for determination of air contaminants including radioactivity. These stations can detect the contribution of radioactivity due to atomic weapons testing in the United States or overseas. The disadvantage of the existing procedure is that (1) only the total radioactivity for the period of operation (usually a day) of the sampler is measured and (2) there is a one to four day interval between the time of collection and physical measurement of the radioactivity.

3. Milk

The only active program carried out to date for determining levels of radioactivity in milk is that of the Public Health Service and the Atomic Energy Commission. The presently accepted techniques in determining Sr^{90} in milk is a tedious and time-consuming procedure. It is expected that the technique developed by the Division of Laboratories and Research for determination of gross beta activity for all calcium like radioelements will be accepted generally as a standard procedure. In any event, interpretation of these results can be related indirectly to fallout and thus a study on a micro-geographical scale could be undertaken by the Health Department.

Plans are now being made to submit at monthly intervals samples from five selected milk sheds throughout New York State. These sampling stations will be in addition to milk samples to be collected in connection with the Consolidated Edison Company pre-operational survey.

C. PERSONNEL

A comprehensive Radiological Health Program requires personnel trained and experienced in medicine, engineering, chemistry, physics and biology. In order to efficiently carry out a statewide program, it is also necessary to coordinate the activities with all other existing public health programs such as dental health, water supply, milk and food control, water pollution control, air pollution control and with all other agencies and departments.

1. Central Office

The staff of the Radiological Health Section in the Bureau of Environmental Sanitation is as follows:

Position	Authorized	Filled	Requested 1959-60 Budget
Associate Sanitary Engineer	1	1	
Senior Sanitary Engineer	3	1	5
Assistant Sanitary Engineers	2	1	
Radiation Inspectors (2 month positions for assignment to L.H.O.)			10

The following activities are being planned and carried out with the existing personnel.

a. Training of field personnel in local health units.

b. Compilation of data on results of laboratory radioactive determinations - air, water, milk.

c. Assistance to local field units when requested on special surveys.

d. Coordination of pre-operational survey.

e. Review of hazards evaluation in connection with nuclear reactors and approval of plans for waste discharges when required by law.

f. Maintenance of instruments.

g. A limited study of Mohawk-Hudson River to determine sources and amount of radioactivity being contributed to these surface waters.

h. Establishment of statewide monitoring stations.

2. Regional Office

A budgetary request has been made for 5 positions at the Senior Sanitary Engineer level. If authorized, an engineer would be assigned to each of the Regional Offices to coordinate and develop the general program and in addition train and otherwise assist local health personnel. These engineers would be readily available to the local health units and also be of assistance in the development of a disaster program on a regional or local county level.

3. Local Health Departments

There is in all but four of these local health units personnel trained for making inspection of X-ray installations. Subject to personnel shortages, a program for such inspection could be carried out at the present time.

Insofar as the other programs including inspection of users or processors of radioactive materials, atomic power plants and related discharges of wastes to the environment is concerned, additional training of personnel is necessary. The immediate needs will be met in part by a course scheduled at the University of Rochester in December. A long range program should include formal academic training of selected personnel in larger local units and two to three month courses on health physics fundamentals similar to the course given at Oak Ridge National Laboratories.

The assignment of Junior Engineers recently employed by the Department to District Offices following suitable training will provide for a satisfactory Radiological Health Program in such units.

D. TRAINING

The training program in radiological health has consisted of short in-service-training courses given to state and local health departments personnel. Implementation of this training program is necessary in the form of continued short in-service-training courses including many other aspects of radiological health and formal academic training of selected personnel. The status of training of Health Department personnel is reflected in the attached Tables 1, 2 and 3. The training courses have qualified a number of Health Department personnel in the routine type of survey of an X-ray installation. Attached is the estimate of training needed in Radiological Health 1959 to 1960.

E. RESEARCH INVESTIGATIONS

The results of any research may have universal application or purely state or local interest and both are being considered. Within the existing limitations of personnel, equipment and money, research projects have been undertaken by the Health Department.

The New York State Department of Health has recently received a research grant to assess the extent of diagnostic and therapeutic X-ray exposure in the general population on a selected statewide population sample.

In cooperation with the Division of Laboratories and Research, a program has been underway and is being expanded which measures the radioactive content of air, water and precipitation. These results are submitted to the Radiological Health Section and current records are

maintained of present levels of radioactivity. It is interesting to note that the monitoring stations do detect radioactivity in the atmosphere which is in part related to the extent of atomic bomb testing in different parts of the world.

III. FUTURE PROGRAMS AND ACTIVITIES

In a Radiological Health Program, the philosophy must be to reduce and eliminate where possible all unnecessary and needless exposure to all persons occupationally or otherwise exposed. In program planning and development all factors must be considered.

A. Radiation Sources

1. Radiation Installation (X-Ray)

At the present time, the use of X-ray in all fields represents a considerable contribution of radiation exposure to the general population. The consultation and inspectional phase of the State Health Department's Radiological Health Program will reduce considerably exposure to ionizing radiation consistent with good medical and dental practice.

It is envisioned in the future that the following activities and programs will be developed either on a national, state or local basis.

1. Determination of the biological effects to humans of repeated low doses of ionizing radiation.

2. Cooperation with the medical, dental and other professions to assist them in the evaluation of the extent of radiation exposure in terms of the need for such exposure.

3. Cooperation with equipment manufacturers to study ways and means whereby the exposure can be reduced in either design and/or use of equipment.

2. Radioactive Materials, Particle Accelerators and Nuclear Reactors

The future program plan in this field must include not only the health and safety aspects in terms of occupational exposure but the resulting consequences which might occur in the form of routine or accidental waste discharges to the environment. It is generally recognized that the atomic energy industry will be growing at a logarithmic rate for many years in the foreseeable future and the controls which are developed and exercised today will minimize the problems in the future. Therefore, the program as outlined for the present must be efficiently developed and expanded where necessary.

A conservative estimate of seven man-years for this phase of the program in 1963 may be inadequate if the industry expands more rapidly than envisioned or the regulatory or surveillance activities must be implemented by additional personnel and equipment.

B. Radiation Control Activities

The further development and expansion of this program is necessary to determine levels of radioactivity and accordingly any increase that may occur as a result of weapons testing or due to routine or accidental releases of fission products into the environment.

1. Water

Increased sampling of surface waters and public water supplies is planned. It is also proposed to compile this data with a breakdown by watershed, type of sample or supply and year of collection. This can be entered on IBM Cards and will afford a quick evaluation of abnormal variations and if such variations are related to known discharges or other meteorological factors.

2. Air

A study is being made to: 1. determine the type of instrument that could instantaneously measure levels of radioactivity of air particulates and 2. the feasibility of establishing a network of such instruments throughout the state. The establishment of such a network will be of immeasurable value if atomic weapons testing is expanded or if nuclear warfare were to occur in any part of the world. These installations could be located, in cooperation with local health departments, at selected points and provision would be made for routinely checking such instruments. All data obtained would be compiled and evaluated to determine the contribution of radioactivity to the population through this media.

A mobile (trailer or truck mounted) air monitor should be included in the planned program of hazards evaluation at nuclear reactors or other users of unsealed sources of radioactive materials. This will be utilized by field inspectional personnel in the routine monitoring of such facilities.

3. Milk

In addition to the present sampling of milk which is proposed, a further study on a microgeographical basis to establish the relationship of radioactivity in the milk and water consumed by cattle appears desirable. It appears that the radioactivity in precipitation too has a marked effect upon concentrations of radioactivity in milk and, therefore, any control procedures to effect a reduction of the radioactivity in milk might be based upon this relationship.

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4. Food

Extensive work is being carried out at the present time by the Atomic Energy Commission to determine levels of radioactivity in foods. One particular aspect of this phase of the surveillance program which may have statewide or local implication might be related to liquid waste discharges. Aquatic organizms concentrate specific radioisotopes such as P-32 many thousand times the level in water. Therefore, the use of these organizms for human or animal consumption presents a potential public health problem.

C. PERSONNEL

The filling of authorized positions in the Radiological Health Section would permit a more comprehensive program as follows:

1. Assignment of personnel to local health units for limited periods of time (1 to 3 months) to develop a program and train personnel.

2. Provide assistance for all local units with particular emphasis on installations using or producing radioactive materials.

3. Develop research programs in the field of radiological health.

The recruitment of trained personnel in the field of radiological health is admittedly difficult. For example, two young engineers employed by the Health Department for a short time, completed a years' post-graduate training in Radiation Biology and upon completion of the course work, left the state for employment in private industry.

Any personnel consideration should also include a physician experienced in physics and the biological effects of ionizing radiation.

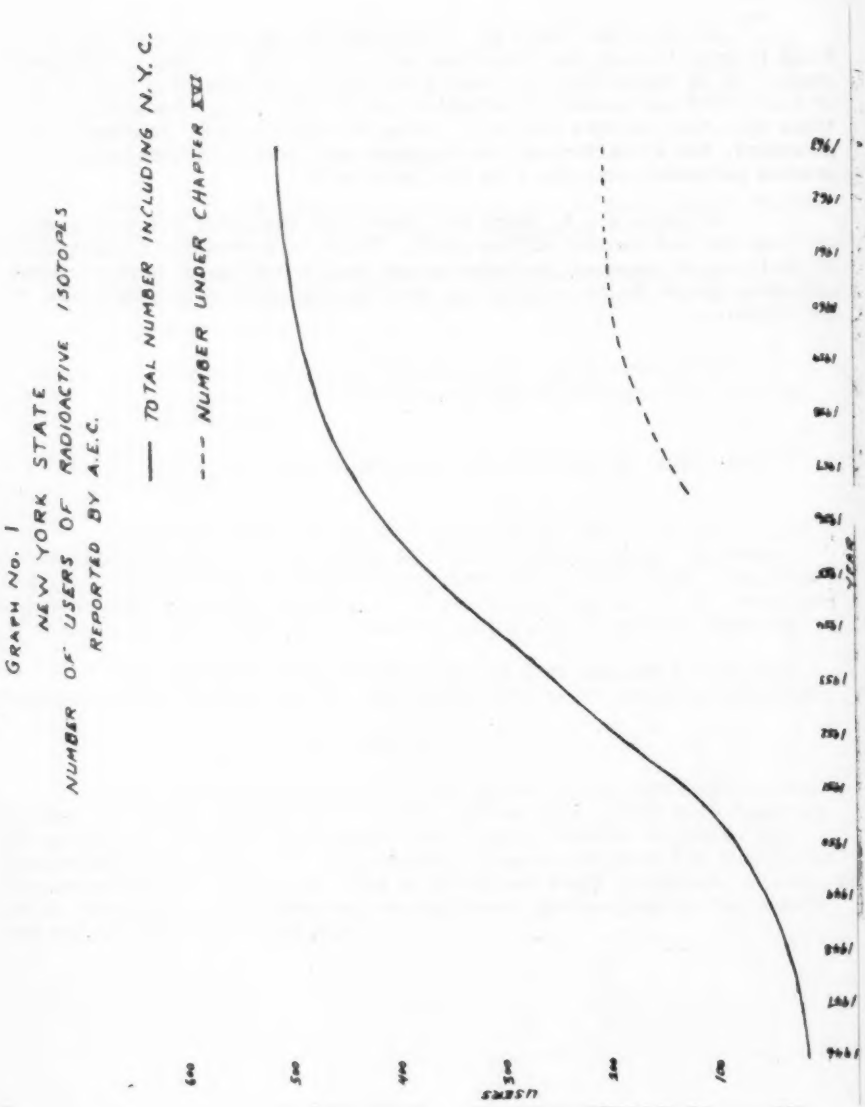
D. TRAINING

The attached estimate of training needed in radiological health in New York State during the five year period 1959 - 1963 will expedite as quickly as possible the overall Radiological Health Program. The favorable consideration of this training program provides for fulfilling the immediate and long-range need of field and staff personnel, as well as other personnel in industry and the different professions in the health and safety aspects of radiation.

E. SUMMARY

The attached Table No. 7 outlines the personnel needs for a field program to meet the immediate and future needs in the inspectional phase. It is recognized that work loads will vary depending upon size of local unit and number of installations in such unit. Because of these and other factors including status of training and experience of personnel, the state through the Regional and Central Offices must provide personnel assistance to the local unit.

In Table No. 8, there are listed the estimated manpower needs for Regional and Central Office staff. There is provision for continuation of training of personnel in radiological health and one or more of these engineers should be re-assigned to local health units upon completion of the training.


GRAPH No. 1
NEW YORK STATE
NUMBER OF USERS OF RADIOACTIVE ISOTOPES
REPORTED BY A.E.C.
— TOTAL NUMBER INCLUDING N.Y.C.
--- NUMBER UNDER CHAPTER XXI
USERS
YEARS

BUREAU OF ENVIRONMENTAL SANITATION
RADIOLOGICAL HEALTH

PERSONNEL

	1959-1960 Authorized	1959-1960 Requested	Yearly Increment Personnel Per Year 1959-64	Estimated Need 1963-1964
Associate Sanitary Engineer	1			1
Senior Sanitary Engineer (or Health Physicists)	3	5	3/5	11
Assistant Sanitary Engineer	2		1	7
Radiation Inspectors (2 month employment)		10	1	15
Electronic Technician		1		1
TOTAL	6	16	3 3/5	35
COST	$94,740		$14,800	$153,960

EQUIPMENT

	1959 - 1960	Yearly Cost For Period 1959-1964
Environmental Monitors	$38,000.00	$10,000
Portable Survey Instruments	5,294.90	3,000
Maintenance and Supplies	2,000.00	4,000
COST	$45,242.90	$17,000

TRAINING

	1959-1960	Yearly Cost For Period 1959-1964
Personnel	$52,270	$52,270

TOTAL COST 5 Years (1959-1964)

Personnel	$ 648,846.00
Equipment	113,242.90
Training	261,360.00
	$1,023,448.90

Average Cost Per Year - $204,689.80

TABLE NO. 1

DISTRICT OFFICES

RADIATION INSTALLATIONS (X-RAY) REGISTERED AS OF DECEMBER 31, 1957 AND PROGRAM STATUS 1958

	No. of Installations**	No. of Machines	Personnel in Unit Completing In-Service Training Courses	Inspections During 1958
Binghamton	96	121	*	*(1)
Geneva	57	NR	*	
Glens Falls	84	98	*	(1)
Hornell	137	171	*	*(1)
Jamestown	73	80	*	*(1)
Johnstown	46	69	*	*
Lockport	80	86	*	*(1)
Middletown	83	108	*	*(1)
Oneonta	106	128	*	
Poughkeepsie	65	NR		District Office Closed
Rochester	211	NR		District Office Closed
Saranac Lake	116	137	*	*(1)
Syracuse	80	88	*	
Utica	145	196	*	
Watertown	69	84	*	(1)
TOTAL	1448			

** Includes 183 shoe-fitting fluoroscopes and chiropractors
* Over 50% of units will be inspected in 1958
(1) Part-time employee assigned on Radiological Health by B.E.S.
NR No report
Ratio Number of Installations to Number of Machines 1:1.2

TABLE NO. 2

COUNTY HEALTH DEPARTMENTS

RADIATION INSTALLATIONS (X-RAY) REGISTERED AS OF DECEMBER 31, 1957 AND PROGRAM STATUS 1958

	No. of Installations**	No. of Machines	Personnel in Unit Completing In-Service Training Courses	Inspections During 1958
Albany	NR	NR	*	
Cattaraugus	56	99	*	
Chemung				New County Unit
Clinton	40	NR	*	
Columbia	27	NR		
Cortland	29	36	*	*
Dutchess	NR	NR	*	New County Unit 1958 (1)
Erie	808	NR	*	
Genesee	27	34	*	
Monroe			*	New County Unit 1958
Nassau	530	NR	*	
Rensselaer	110	137	*	*
Rockland	54	NR	*	(1)
Schoharie	12	NR	*	
Seneca	22	22	*	*
Suffolk	157	NR	*	
Tompkins	53	100	*	*
Ulster	53	NR	*	*(1)
Westchester	305	NR	*	*
Wyoming	20	23	*	*
TOTAL	2311			

** Includes 290 shoe-fitting fluoroscopes and chiropractors
* Over 50% of units will be inspected in 1958
(1) Part-time employee assigned on Radiological Health by B.E.S.
NR No Report

Ratio Number of Installations to Number of Machines 1:1.4

TABLE NO. 3

CITY HEALTH DEPARTMENTS

RADIATION INSTALLATIONS (X-RAY) REGISTERED AS OF DECEMBER 31, 1957 AND PROGRAM STATUS 1958

	No. of Installations**	No. of Machines	Personnel in Unit Completing In-Service Training Courses	Inspections During 1958
Binghamton	105	NR	*	*
Mt. Vernon	113	NR	*	
New Rochelle	92	100	*	*
Niagara Falls	74	NR		
Rochester	422	477	*	*
Schenectady	145	163	*	*
Syracuse	143	NR		
Utica	37	57	*	
Yonkers	63	96	*	(1)
TOTAL	1194			

** Includes 91 shoe-fitting fluoroscopes and chiropractors

* Over 50% of units will be inspected in 1958

(1) Part-time employee assigned on Radiological Health by B.E.S.

NR No Report

Ratio number of installations to number of machines 1:1.2

TABLE NO. 4

SUMMARY OF NUMBER OF RADIATION INSTALLATIONS (X-RAY)

	Registered as of Dec. 31, 1957*	** 1958	For Yearly Inspection Man-Years	*** 1963	For Yearly Inspection Man-Years
District Health Offices	1448	1590	3.6	1670	3.8
County Health Depts.	2311	2520	5.7	2675	6.1
City Health Depts.	1194	1380	3.1	1449	3.3
TOTAL	4953	5490	12.4	5794	13.2
			Reinspection at two-year intervals		6.6

* Includes 564 Shoe-Fitting Fluoroscopes and Chiropractors
** Not including Shoe-Fitting Fluoroscopes and Chiropractors
*** Estimated

TABLE NO. 5

USERS OF RADIOACTIVE MATERIALS REGISTERED WITH LOCAL HEALTH DEPARTMENTS AS OF DECEMBER 31, 1957

	Hospitals	Universities	Laboratories	Other	Total
District Office	33	2	1	6	42
County Health Dept.	4	2	1	1	8
City Health Dept.	36	18	5	1	60
TOTAL	73	22	7	8	110

LOCATION AND TYPE OF ALL USERS IN NEW YORK STATE
(INCLUDING NEW YORK CITY)

February 10, 1956 - May 31, 1958*

Hospitals	Colleges and Universities	Industrial Firms	Federal & State Institutions	Foundations and Institutions	Other	Total
255	21	150	30	4	5	465

* Report U.S. Atomic Energy Commission - July 1958

TABLE NO. 6

NUCLEAR REACTORS (RESEARCH, POWER & TRAINING)

1958

Location	Type
Pawling Dutchess County	Pawling Research Reactor - N.D.A. 5 Watt - Tank Type - Heavy Water
West Milton Saratoga County	Submarine Advanced Reactor Prototype - Pressurized Water
Upton Suffolk County	Brookhaven - Research Reactor Graphite
	Brookhaven - Neutron Source Reactor - Tank
Buffalo Erie County	University of Buffalo Pool
	OPERATION 1960
Sterling Forest Orange County	Union Carbide Nuclear Co. Tank
Indian Point Westchester County	Consolidated Edison Company Thorium Reactor - Pressurized Water 151,000 KW Nuclear
Schenectady	Destroyer Reactor Prototype Pressurized water
Ithaca	Cornell University Pool

TABLE NO. 7

PERSONNEL NEEDS FOR FIELD PROGRAM

MAN-YEARS

Type of Installation	1958	Man-Years	1963	Man-Years
Medical and Dental X-Ray	5490	12.4*		6.6**
Users of Radioactive Materials	235	3	255	4.0
Nuclear Reactors	4	1	9	3.0
Special Installations and Studies (Including milk, air, water, and food)		2		3.0
TOTAL		18.4		16.6

*Required to initially inspect all installations
**Schedule reinspection at intervals of one, two or three year as needed

TABLE NO. 8

PERSONNEL NEEDS

REGIONAL AND CENTRAL OFFICE

	1958	1963
Assistance to Local Health Departments	7*	6*
Continuation of Training	3	3
Special Investigations and Research	1	3
TOTAL	11**	12

*Includes five engineers for assignment to Regional Offices

** 1 Associate Sanitary Engineer
8 Senior Sanitary Engineers
2 Assistant Sanitary Engineers

12/1/58
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Representative HOLIFIELD. During these hearings we have reserved the right to include at appropriate places, papers which have been submitted pertinent to the testimony which has been given, and at this point we have a number of important papers, that will be inserted in the record. We want this record to be not only a compendium of those who have give oral testimony, but also to contain some very fine papers that have come from authoritative sources, people who could not be here or whose time did not permit the opportunity of personal testimony.

(The material referred to follows:)

STATUTORY RESPONSIBILITIES OF THE U.S. WEATHER BUREAU IN RELATION TO RADIOACTIVE WASTE DISPOSAL

(By F. W. Reichelderfer, Chief, U.S. Weather Bureau, Department of Commerce)

The Weather Bureau is charged with the responsibility of "forecasting of weather * * *, the distribution of meteorological information in the interests of agriculture and commerce, and the taking of such meteorological observations as may be necessary to establish and record the climatic conditions of the United States, or as are essential for the proper execution of the foregoing duties" (15 U.S.C. 312).

These statutory responsibilities of the Weather Bureau relate to radioactive waste disposal in two ways. First, the competence developed by the Weather Bureau in the collection and interpretation of meteorological data is available to Federal, State, and local governmental agencies for application to specific problems. As an example, there is the work done by the Hydrological Section of the Weather Bureau for the Corps of Engineers in interpreting meteorological data in terms of maximum storm tides, maximum precipitation, etc., which permits the Corps of Engineers to better estimate the results of severe storms. Another such example is the work of the Weather Bureau's Fruit Frost Service in providing information of economic value to agriculture and which has enabled the savings of millions of dollars in crop damage. The effect of the atmosphere in the transport and dilution of radioactivity is such a special problem and the Weather Bureau provides direct research and operational service and advice to such agencies as the Atomic Energy Commission, National Aeronautics and Space Administration, the Maritime Administration, to mention several. In additon, pertinent Weather Bureau meteorological records, and informal discussions with Weather Bureau specialists in the field, are available through established procedures to private industrial groups and to colleges and universities. Weather Bureau research in the field of atmospheric diffusion and air pollution are published in the meteorological literature and in 1955 the Weather Bureau prepared, for the Atomic Energy Commission, the publication "Meteorology and Atomic Energy," in which we attempted to summarize the meteorological techniques applicable to the nuclear energy field.

The planned or accidental release of airborne radioactivity may affect major areas, perhaps extending downwind for hundreds of miles. The atmosphere moves in its course regardless of State or National boundaries and because of this unhindered mobility and the speed with which airborne material travels (500 miles in 24 hours would not be unusual), a broad network of weather observations and communications is required to maintain surveillance on aid streams transporting radioactivity. Such an extensive meteorological network is maintained by the Weather Bureau. From this network, and from the numerous (more than 250) Weather Bureau offices throughout the United States, continuous analyses of wind flow and weather are prepared which are pertinent to the large-scale, long-distance (more than 50 miles) transport of radioactivity. This information can be made available to interested organizations. It would of course be necessary to establish in advance, the necessary organizational liaison with nuclear installations since the problem of atmospheric transport is a complicated one.

We should mention here that the problem of short-range (less than 50 miles) airborne travel and diffusion of radioactivity is a very specialized problem and its estimation and forecasting usually requires detailed meteorological measurements near the source, knowledge of the physical state of the radioactivity

released, and a comprehensive understanding of the time and conditions of release of the material. For this reason many operators of nuclear installations have special meteorological organizations (which may be operated by private industry or, in the case of certain Federal installations, by the Weather Bureau) to analyze these problems. The national meteorological service of the Weather Bureau would be supplemental to, not a replacement for, such special services. The Weather Bureau, through past experience in the evaluation of proposed nuclear sites, the operation of micrometeorological services, and established 24-hour-per-day meteorological services to major cities from our regular field stations, has unique facilities for providing broad scale comprehensive meteorological information on the atmospheric disposal of industrial radioactive waste.

In conclusion the Weather Bureau envisions its role in the problem of industrial radioactive waste disposal as cooperating with the appropriate agencies in providing the basic meteorological information and services required for efficient and safe utilization of nuclear energy.

ACTIVITIES OF THE UNITED STATES GEOLOGICAL SURVEY IN PROBLEMS OF RADIOACTIVE-WASTE DISPOSAL

Presented by
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Biographical sketch of R. L. Nace

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INTRODUCTION

The Federal Government must assure that human and other life are not damaged by radiation as a result of the development and testing of nuclear energy. The Geological Survey has an important role in this responsibility because the protective containment or disposal of radioactive wastes in or on the ground involve earth sciences which are the special province of the Survey.

The Atomic Energy Commission is justly famed for the thoroughness of its efforts to assure that workers in the field of nuclear energy are protected from radiation hazards. The Commission's attention to waste-management and to protection of public health also is notable and probably is without parallel in the history of science and industry. Nevertheless, the problem of ultimate disposal of radioactive waste remains with us.

Most schemes for the disposal of radioactive waste involve treatment of the waste, followed by injection, discharge, or burial in the ground, by dispersal in surface water, or by dumping at sea.

In short, the only places available for disposing of nuclear wastes are on or in the earth.

The general function of the Geological Survey is to study the earth--(a) its origin and history, (b) the materials of which it is composed, (c) the nature, occurrence and structure of these materials, (d) the landforms, and (e) the geologic processes that have operated since the beginning of earth history. By understanding geology and geologic processes we can intelligently seek, find, and evaluate mineral deposits and water resources. Seemingly, no one could have foreseen, until a few years ago the development of this new nuclear-energy industry or the generation of large amounts of waste fission products which must be contained or disposed of in the geologic environment. Nevertheless, our knowledge of the basic principles of earth sciences enable us to see clearly the potential threat of fission products to our physical well being, and especially the threat to our water resources. These same principles, however, may be expected to provide us with the keys to safe management of water in geologic environments.

IMPORTANCE OF THE PROBLEM

We are confident that one or more acceptable solutions will be found for problems of radioactive-waste disposal, but no generally acceptable plan has yet evolved for final disposition of the large quantities of highly radioactive wastes that are anticipated in the future. No solution other than semi-permanent storage in artificial structures is available now for the containment of high-level wastes. The present practice of storing high-level waste in tanks is a temporary expedient inherited from wartime. It is temporary because, even if tank storage should ultimately turn out to be the most economical means for management of wastes, the serviceable life expectancy of the tanks themselves may be only a fraction of the hazard-life of some of the fission products they contain.

The problem has national importance because the volume of radioactive waste produced annually will increase markedly within a few years. Government responsibility is obvious because the effective hazard-life of many fission products exceeds the life-expectancy of ordinary human organizations.

The term "waste disposal" implies (a) that the waste is collected and controlled at will and (b) that it is disposed of at a chosen place in a controlled manner. Since the wastes are dangerous to all living things, a choice of the means or the place of disposal implies that by such means or at such place we know that danger is eliminated or is negligible. The extent to which this is true will be considered later.

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The Potential Threat to Water Resources

Fission products from nuclear-energy reactors include isotopes of 37 different elements, most of which are radioactive. They include the transuranium elements and their daughter products, and they occur in a wide variety of solid, liquid, and gaseous forms. The bulk of the waste fission products is in liquid solutions. For all of these, means are sought for safe disposal by dispersal or storage in natural environments.

Safety is the first requirement in water management. To achieve safety requires the application of many scientific disciplines and the participation of many agencies and institutions. Continuous surveillance also will be necessary. For example, published figures (U. S. National Bureau of Standards, 1953) on the maximum permissible concentration (MPC) of radioactive materials in drinking water define the activity levels above which body damage may occur if exposure is continuous and prolonged for many years. Waste management necessarily includes monitoring to assure that standards are adhered to.

Many people, including some scientists, mistakenly believe that running water in streams and in the ground somehow purifies itself in short distances or in a short time. Water, especially ground water, does "purify itself" somewhat, especially of bacterial pollution; contaminants may be filtered out or, where air is present in water, organic contaminants may be oxidized, for example. But we cannot rely on "self-purification," except under known or demonstrated conditions, especially if the contaminants are radioactive dissolved solids. Like other solids, these are removed from water in nature only under specialized conditions. Moreover, the radioactivity of contaminants may be dangerously high even when, in a chemical sense, they are present only in vanishingly small amounts. Water that is very pure in a chemical sense may be very dangerous in a radiological sense.

The usual history of water is one of progressive addition of dissolved solids, not of losing them. Rainwater contains only trace amounts of dissolved solids, but as soon as the water enters the ground or surface streams it dissolves some of the materials with which it comes in contact. By the time the water returns to the sea it is quite a complex chemical solution. Natural water contains nonradioactive isotopes of some elements whose radioactive isotopes occur in waste fission products. The water will carry one as well as the other. Chemical processes like ion-exchange may decrease the concentration of radioisotopes in the water somewhat, but natural processes do not remove dangerous elements just because they are radioactive. That is, radioactivity itself does not predispose an isotope to base exchange or adsorption.

Water is a universal solvent, so fission products, whether solid or liquid, radioactive or stable, may be picked up by water and carried in solution. "Solubility," moreover, is a relative term. Practically nothing is absolutely insoluble in water, and "insoluble" radioactive materials may be dissolved in sufficient quantity to make water highly dangerous. Water also transports solid material as sediment. Therefore, any radioactive solid matter that gets into water may be transported as sediment.

The waters on the land, whether in streams or in the ground, are constantly on the move, headed toward the sea or toward interior drainage basins like that of Great Salt Lake. Therefore, any waste that is released on or in the ground may be moved by natural water either in solution or in sediment. The big questions are, Can the hazardous materials be immobilized? If they move, how will they affect the usability of water supplies? What paths will they follow? Where will they stop? How long will it take? and Will they be concentrated or dispersed? Even when we can answer these questions, we will not have really solved any problem. We will have merely described a situation. The biggest question of all is, How can we isolate and immobilize the hazardous materials so as to prevent any harm at all to water supplies or to other natural resources?

Principal Sources and Amounts of Waste Materials

The principal production of liquid radioactive wastes is in the chemical reprocessing of used nuclear-fuel elements from reactors. The fuel is reprocessed to recover unused fissionable materials. Waste from experimental laboratories and other facilities is relatively small in volume though some of it is highly radioactive.

The status of reactor developments in the United States is summarized in a recent report of the U. S. Atomic Energy Commission (1958a, p. 79-112, 335-343)[1/]. The status of reactors for the generation of electrical energy is of special interest. As of June 1958, the date of the AEC report, the nuclear-electric power output capacity was expected to reach 77,600 kw in 1958 and 1,326,500 kw by 1963. The producing plants will be widely distributed in the United States.

Very few of the reactors now in operation were built primarily for the generation of nuclear-electric energy, but most of the proposed large new reactors are for that purpose. So the big, radioactive-waste problem of the future will be with waste from the reprocessing of fuel elements used in the nuclear-electric industry.

Less than a score of reactors of all kinds have been built and operated for appreciable periods in the United States. Yet more than 60×10^6 gallons (10^6 = 1,000,000) of highly radioactive liquid waste already is stored in underground tanks. Single tanks hold 0.3 to 1.0×10^6 gal. Continued buildup of storage--or even indefinite continuation of present storage in liquid form--is not desirable because it is only a holding operation until a satisfactory disposal method can be found.

1/See list of "References cited" at end of this paper.

According to estimates now current, there may be about 700 reactors in operation by 1980. Eliassen (1957) estimated that by 1980 we may be producing fission products having a total radioactivity of 100×10^9 ($10^9 = 1{,}000{,}000{,}000$) curies per year. The estimated accumulated volume of stored waste may be 200×10^6 gal by 1980, 600×10^6 gal by 1990, and $2{,}400 \times 10^6$ gal by 2000. In 1965, waste fission products may be produced at a rate of about 10 kg per day (Nat. Acad. Sciences--Nat. Res. Council, 1956, p. 103-104).

Concurrently with high-level waste problems on the land, low-level waste may also become a factor in the marine environment. Some authorities believe the most rapid early future development of reactors by the United States will be for ship propulsion. Available information (Schmidt and Fidrych, 1958, p. 10) indicates that waste liquid from these will be discharged overboard. Presumably this will be only low-level waste. Sea-going reactors, however, are not the sole source of sea contamination. Packaged and concreted waste from land reactors is dumped at sea by the United States and other countries. Reportedly, the United States has dumped about 10,000 curies of waste into the Atlantic Ocean and a lesser amount in the Pacific. Still another source of marine contamination is waste discharged to streams or in ground water in the land areas. This actually is indirect sea disposal, because most of the water finally goes into the ocean.

The Final Problem

The use of nuclear energy has created an entirely new kind of geologic problem in the control of industrial pollution. Waste of any kind that is released may ultimately reach man or his immediate environment through one channel or another. A single release of radioactive material may be inconsequential in itself, but the integrated total of many releases may be of great consequence. Therefore, disposed waste must be diluted so thoroughly or segregated and contained so effectively, that the waste, during its active life, shall not endanger living things or interfere with the use of natural resources, known or unknown.

A simple illustration will help to clarify the scope of the problem implied by the above requirements. The tolerance limit that is generally accepted for mixed radioisotopes in drinking water in the United States is 10^{-7} μc/ml (microcuries per milliliter; 10^{-7} = 0.0000001) (U. S. National Bureau of Standards, 1953, p. 11), or 420 curies per cubic mile of water. At a waste-production rate of 100×10^9 curies per year by 1980, dilution of the waste produced in one year to acceptable limits would require 238×10^6 cubic miles of water. The total volume of water in the oceans is 317×10^6 cubic miles. This gives us a useful yardstick. The figure, 100×10^9 curies per year, probably is quite meaningless to most of us. We can appreciate it better if we realize that, allowing for continual decay of the radioactivity, enough will be generated by 1980 so that the entire volume of the ocean would be needed to dilute the activity generated by about two years of reactor operations.

Obviously, the major portion of all radioactive waste that is generated will have to be contained in some manner. Tank storage of this material would be physically possible but the danger of accidental release would be an ever-growing biological threat. This is the basic consideration in all handling of radioactivity. The final problem is the protection of life. This final problem leaves but two alternatives: (1) all dangerous waste must be kept under direct physical control or, (2) if released, the waste must be put into the environment in such a way that it is not, and cannot become, a direct hazard. Alternative (2) is the one that concerns the geologist and hydrologist most and the one which receives the principal effort of the Geological Survey in waste-disposal problems.

NATURE OF THE WASTES

The principal share of the solid fission products generated by nuclear reactors is concentrated during the reprocessing of used fuel-elements in a comparatively small volume of highly radioactive liquid waste. The intensity and longevity of the radioactivity in the waste are so great that it could be released in natural environments only under very special conditions. The acceptable conditions for release will be discussed later.

Each radioisotope has its unique half-life[7/] and each differs from the others in the kind and intensity of its radiation. Some radio-isotopes are very short-lived. Therefore, from the long-term point of view, the isotopic composition of a waste solution at the instant it comes out of a chemical-separation plant is relatively unimportant if the material is to be "cooled" in storage for a period of time. The composition after "cooling" for a term of years is more important because (a) the content at that time consists chiefly of materials that are long-term hazards, and (b) stored material is most apt to escape after a term of years in storage—that is, after the storage structure itself has deteriorated.

7/ The half-life of an isotope is the length of time during which half of the original quantity disappears by radioactive decay. After 6 half-lives only about 1.6 percent of the original radioactivity remains. After about 10 half-lives practically all of the isotope vanishes.

From published data it seems evident that the hazard-life of some high-level wastes may extend through periods of time that are geologically significant--that is, at least for hundreds of years and perhaps for thousands. Many geologic processes are very slow compared to human lifetimes, but they can bring about significant effects in a few generations or centuries. Thus, the behavior and ultimate fate of wastes must be understood in terms of factors that operate through relatively brief but significant intervals of geologic time.

Nearly every reactor and nuclear-energy laboratory produces its own specific type of radioactive byproducts, but most of these fall into two principal categories, based on the level of radioactivity: low-level and high-level materials. Low-level radioactive solutions have activities of as much as 10^{-3} microcuries per milliliter. High-level solutions contain more than 100 curies per liter (Straub, 1958).

The Division of Reactor Development of the Atomic Energy Commission defines high-level radioactivity as emitted activity so strong in intensity that the exposure time of persons must be limited. Two roentgens or more per hour is classed as high-level radiation (U. S. Atomic Energy Commission, 1957, p. 3). The radioactivity is called low level when the radiation is no particular hazard to anyone nearby. Radiation below 50 milliroentgens is called low-level. Radiation activities between these extremes commonly are called intermediate level; these may be produced (1) by partial decay of high-level materials, (2) as residual material following the separation of strontium and cesium from a waste solution, or (3) from originally low-level solutions that have been concentrated by evaporation.

Generally, the low-level solutions are disposed of, after decontamination by a factor of 100 to 1,000, or by dispersal in natural environments where adequate dilution is available. The high-level materials are confined in artificial containers. Intermediate-level materials generally have activities of several to many times the maximum permissible concentration in drinking water, but are very low or lacking in the more long-lived radio isotopes such as those of strontium, cesium, and plutonium. In some places intermediate-level wastes are being released to the environment, where they are amenable to only partial control.

Some people believe that the problem of high-level wastes may be solved by salvaging fission-product isotopes for beneficial use in industry and agriculture, in biological studies, and in medical services. Although many of the isotopes could be salvaged, not all the long-lived ones are usable now, and none are economically recoverable. For example, strontium, cesium and the rare earths may be separated and recovered. But this would not eliminate the need for storage of the residual waste at least for some years or decades. Their removal would lower the radioactivity of the waste by a factor of 10,000 to 1,000,000, but the activity of the residual liquid would still be 1,000 to 100,000 times greater than could be safely released to the environment (U. S. Atomic Energy Commission, 1958, p. 4). Therefore, the need for storage of wastes will continue in the foreseeable future.

The distribution of radioisotopes on an appreciable scale for medical, scientific, industrial, agricultural and other uses began in August 1946. In 1956, after 10 years, about 100,000 shipments of isotopes had been made to about 3,200 institutions throughout the United States (Nat. Acad. Sciences—Nat. Res. Council, 1956, p. 104). Oak Ridge National Laboratory, the principal shipper, had shipped about 130,000 curies. In the three years, 1954-56, the number of using institutions increased 125 percent—from 1,400 to 3,200. Further increase in the use of highly radioactive material at widely scattered locations for industrial, medical, research, and other uses will raise increasing problems in the disposal of wastes. This distribution of isotopes is, in effect, a form of dispersal.

Public use of isotopes is controlled, and management and disposal of their wastes is supervised, but extensive increase in this use will create a tremendous policing problem.

Low-level solutions are produced in much larger volumes than the high-level ones. Although their disposal is not an immediately serious problem, they may become such a problem as our nuclear-power economy expands. The volume of water in many streams may be inadequate for dilution of the low-level solutions, especially during extended periods of low flow. About 95 percent of the low-level short-lived liquid waste now produced is disposed of by discharge into streams, lakes, and reservoirs. Under some circumstances natural processes concentrate the activity in aquatic organisms and in silt deposits. Where the total cumulative activity is large, this concentration may become serious. Waters that receive cumulatively significant amounts of waste materials must be monitored systematically.

Storage or disposal methods for high-level waste, to be satisfactory, must assure essentially 100-percent confinement for about 100 years and a very high percentage of confinement for centuries thereafter. As was indicated previously, hundreds or thousands of years may be necessary for the radioactivity of high-level wastes to decay to safe levels if the more noxious elements are not removed. A failure in containment or immobilization of a mass of waste might contaminate large areas for centuries. Therefore, selection of truly safe methods and sites for the storage and management of high-level waste materials requires very careful hydrologic and geologic evaluation of each method and each site.

Even if high-level materials never are purposely put into the ground, large areas could be contaminated (a) by accidental release from a reactor or chemical-processing plant, (b) by leakage or complete failure of storage tanks, (c) by accident during the processing, transportation, or storage of wastes, or (d) by warfare. So it is essential to know what situations may be expected and what emergency corrective measures might be taken to minimize the hazard to human welfare and loss of natural resources.

MEANS FOR DISPOSAL

Means for the management of radioactive wastes in the environment are of three general kinds: Controlled containment, partially controlled containment, and dispersal. Three related ways are available to control ordinary industrial contamination of water: by elimination of contaminants, by dilution of contaminants, and by treatment of the water to remove or neutralize contaminants.

Elimination of contaminants is the ideal alternative, but it seems to be out of the question with fission products. Nuclear energy is too big a challenge for mankind to abandon its use, and no process to eliminate the fission products is available.

Dilution of industrial contaminants of all kinds has been practiced, wittingly and unwittingly, for centuries. The method has many advantages but is always a failure where its limitations are ignored.

Treatment of wastes and of water has been successful for some kinds of industrial chemical contaminants, and comparable methods have been used for treating nuclear wastes. The problem, however, is wholly different in the two cases. Many chemical contaminants can be rendered innocuous by neutralizing them or otherwise making them harmless. Organic contaminants, for example, can be oxidized. But there is no known way to neutralize radioactivity, and the wastes cannot be "treated" in the ordinary sense. They must be physically removed from places where they are a hazard to places where they are not.

The common storage facility now used for radioactive wastes is a steel tank enclosed in a heavy concrete shield and set below ground level. As additional wastes accumulate, more and more ground will be occupied by tanks. Very likely, storage tanks always will be needed for temporary storage and "cooling" of high-level waste, even after means are developed for ultimate disposal of the wastes.

At places where intermediate-level wastes are being discharged directly to the ground in infiltration pits, the adjacent ground and ground water are monitored. When evidence is found that radioactivity is spreading, the pits are abandoned and new ones are dug.

By dedication of land for storage tanks, release of intermediate-level waste, and burial of solid waste, a few acres of land are sacrificed each year. The land could not be used again for most other purposes for many years or centuries. In this respect, the nuclear-energy industry does not differ in principle from many other industries which destroy or impair the utility of land and water. Sacrifice of some land is part of the price to be paid for development. Therefore, the choice of disposal and storage sites must be guided so as to cause minimum contamination of the water supply used by this and future generations, and minimum forfeiture of land and known or expectable mineral resources.

Meantime, no structure of concrete and steel, such as a waste-storage tank, will remain intact indefinitely. Tank structures, moreover, are not likely to be completely proof against earthquake damage, and such damage might release large volumes of high-level waste. For that reason, earthquake-prone areas have been avoided in the storage of high-level waste. In case of leakage or complete escape of stored waste, natural geologic factors in the environment would provide the principal long-term basic protection from damage. In the final analysis, therefore, all existing and potential methods for the storage, containment, or dispersal of radioactive waste on the land, would depend for their final effectiveness on geologic factors. That is the reason why the Committee on Waste Disposal of the National Academy of Sciences—National Research Council said in its final report that the disposal problem is primarily one for geologists (Hess, 1957).

Methods that have been proposed by various organizations and individuals for confining high-level wastes include storage in surface tanks; storage in abandoned mines; storage in underground cavities excavated in salt formations; storage in natural underground caverns, as in limestone; injection in deep geologic formations whose structure is closed, i. e., from which the liquid could not escape; sinking in ocean deeps where the turnover of water is very slow; and other methods. Conversion of wastes to solid form has been suggested also, as by casting in concrete, evaporating the liquid and fusing or sintering the solid residue in ceramic materials, and by ion-exchange onto clay followed by sintering of the clay. The "insoluble" solid compounds thus produced would be disposed of by dumping at sea or by permanent burial on the land. All these methods would use geologic environments as ultimate resting places for the waste.

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Various organizations and individuals have also proposed disposal methods for low-level waste that would depend for their effectiveness on dilution by natural water. These proposals assume that waste solutions which reach a surface stream or the water table will be diluted promptly and reduced to harmless levels of concentration. Some dilution assuredly will occur by molecular diffusion, by turbulent mixing in surface streams, and by other processes. These factors are susceptible to determination by investigation, but we do not yet know how much dilution will occur or how rapidly, or what processes of natural decontamination are most effective in various environments. In short, we cannot at this time put a numerical "tag" on the dilution factor. Calculated risks are mentioned frequently in the nuclear-energy industry. But how can a risk be "calculated" under these circumstances? These risks would be only premeditated. Until further study of specific environments and localities enables us to say how much natural dilution will occur and how fast, the only safe procedure is to count on no natural dilution. At places where radioactive waste would be a hazard, it should be released only at innocuous levels, and natural dilution should be regarded solely as a safety factor for protection against accidents unless and until dilution factors are determined in advance.

On the other hand, the opposite process of concentration, which also occurs in nature, must not be overlooked. Waste that is dilute when released may be concentrated to hazardous levels by living organisms such as fish, plankton, and water plants, and also by adsorption and ion-exchange on stream-channel sediments. These processes need extensive study because they can operate even where only low-level waste is present, and may lead to concentration of isotopes at unpredicted places.

How Safe is Disposal in the Ground?

At certain places in the United States intermediate-level radioactive wastes have been discharged to the ground for some years. No identified important biological harm to organisms has occurred from radioactivity at these places because natural geologic and geochemical factors are furnishing some protection. Some people believe, incorrectly, that disposal of these wastes to the ground is no longer an interim or trial procedure. They say it is now an "acceptable" procedure that may be used indefinitely. Actually, we cannot safely say, without further detailed study, that disposal in the ground on a large scale or for a long time is "safe" for any waste unless each disposal area is monitored for possible escape or secondary reconcentration of contaminants at hazardous levels, and unless all hazardous contaminants are irrevocably contained in the disposal area.

Retention of radioisotopes by ion exchange and adsorption in soil and unconsolidated sediment also has received wide notice as a "safety factor." Some operators believe that these processes make it permissible to dispose of intermediate-level wastes in the ground. Ground water moves very slowly and this also is cited as a factor favoring ground disposal, because slow movement allows time for radioactive decay. Ion exchange, adsorption, and slow movement of ground water do indeed afford opportunities for decontamination and radioactive decay. Their effectiveness differs widely, however, with different kinds of earth materials, so each disposal site presents an individual problem which must be studied. Time also is an important factor, and the only general conclusion we can draw now is that, where intermediate-level wastes have been released, escape has not yet occurred.

The ground and ground water have been contaminated at Oak Ridge and Hanford, and perhaps at other places. Whether this contamination will escape remains to be seen with the passage of time. The Atomic Energy Commission is on record that the practices at these places may not be satisfactory for permanent use and that they require continued surveillance (U. S. Atomic Energy Commission, 1949, p. 17).

The storage and management of radioactive waste are expensive, so there will be constant pressure for permission to release waste to the ground and to surface streams. This will be especially true when private industry expands in this field, because industry must make a profit. We must make sure that dangerous precedents do not become entrenched. Precedents are hard to break, especially those in large-scale operations. If disposal practices are allowed now that are found later to be unsafe, the unsafe practices are bound to continue long after their danger has been demonstrated. The best assurance that unsafe practices will not develop and become entrenched is continuous monitoring.

The waste problem cannot be dealt with realistically as something separate from the problems of developing nuclear energy. Reactor design, fuel processing, and the use and disposition of byproducts must be planned together as parts of a single problem. The complete plan should be developed before a site is chosen for a reactor, chemical processing plant, or other facility handling or using isotopes. Scientific study for the control of waste should precede the production of waste, not follow it.

Solid Radioactive Waste

Much of the solid radioactive waste now produced is buried at shallow depth in the earth. The radiation level of these wastes ranges from a few milliroentgens to multiple roentgens (Joseph and Morgan, 1954, p. 4). High-activity material is buried to greater depth than low-activity material. The burial grounds are "dedicated," fenced, monitored, and patrolled. An appreciable percentage of the solid wastes has been disposed of at sea under controlled conditions (U. S. Atomic Energy Commission, 1957, p. 7).

So-called "solid" wastes include semisolid sludges, slurries, and similar materials. The truly solid wastes consist largely of contaminated trash, biological specimens, machinery, scrap metal, laboratory equipment, tools, glassware, paper, towels, clothing, and other materials. The disposal of solid and semisolid radioactive waste material poses problems similar to, but less formidable than, the disposal of liquids.

CAPABILITIES OF THE GEOLOGICAL SURVEY

Geology is the application of all other sciences to a study of the earth, its history, and the processes that affect it. Any location on or in the earth is a geologic environment. The factors in that environment determine how a nuclear plant can or cannot be operated safely, especially in terms of its practices for the management of radioactive materials. So the industry is tied to geology just as closely in the management and operation of plants as it is for its sources of raw materials to produce fissionable fuels.

The geological sciences require widely varied professional skills—those of geologists, geophysicists, engineers, chemists, physicists, biologists, mathematicians, and others. Many of these are precisely the skills needed for the solution of geologic and hydrologic aspects of waste-disposal problems.

Long before the advent of half-tamed nuclear energy, earth scientists were studying natural radioactivity and radioelements because they were important clues to the age of the earth, to the time of events in its history, and to the nature of geologic processes. So we were not wholly unprepared for the so-called atomic age.

The U. S. Atomic Energy Act of 1954 put the responsibility for waste disposal on the Atomic Energy Commission. The Commission, however, had always recognized the basic importance of the earth sciences and already had a history of fruitful collaboration with the Geological Survey and other agencies.

Very early in the period of development of nuclear energy the Geological Survey began systematic collaboration with the Atomic Energy Commission--collaboration (a) in the search for and appraisal of uranium deposits, (b) in the study of proposed reactor sites and test sites, (c) in research on the sites while construction and operation proceeded, (d) in research on the problem of how and where to store and manage the waste products, and (e) in research on how to protect our natural resources, including water. The Survey has studied to varying degrees of intensity most of the important facilities of the Atomic Energy Commission in this country, and has prepared special reports on each. This work is continuing.

The diversity of professional talents in the Geological Survey enables us to study the problem of waste disposal from many angles, and our field organization, with one or more field offices and field staffs in every State and Territory, enables us to work on a wide front at many different places. Because new nuclear-energy facilities--reactors, research laboratories, and test sites--are appearing or are being proposed all over the country, the problem of waste disposal is becoming much more serious and complicated than it was when we had only a few reactors and research laboratories of the Atomic Energy Commission and its contractors.

The Atomic Energy Commission has established a program of study having two principal objectives in relation to "radioactive materials management" (see U. S. Atomic Energy Commission, 1958b, in reference list). These objectives are:

1. To develop practical systems, including equipment and procedures, for the safe and efficient management of radioactive materials, especially solutions of high-level fission products produced by the chemical processing of irradiated reactor fuels.

2. To establish technical criteria for the safe dispersal of low-level liquid, solid, and gaseous radioactive effluents from atomic-energy operations into the environment. This includes quantitative evaluation of atmospheric hydrologic, and geologic variables.

The work of the Geological Survey has direct applications to many phases of these objectives. Plans are proceeding among the Atomic Energy Commission, its contractors, and the Geological Survey for experiments to lock radioisotopes in stable solids and to store liquids in natural geologic structures and formations where they would be contained. Both these measures involve formidable technical problems, only one of which--the heat-dissipation problem--has been partially solved.

Birch (1958) has considered the thermal effects of radioactive waste stored in large quantities deep in geologic formations. Theoretical calculations showed that if certain reasonable conditions were met there would be no undue temperature rise, and no heat problem. Above certain limits of concentrations of radioactivity and of volumes of liquid, however, serious difficulties would arise. Birch's study concerned the heat problem alone in connection with storage of wastes. The study did not concern uncontrollable geologic conditions that might be affected by heat and might introduce hazards not directly related to heat.

ACCOMPLISHMENTS OF THE GEOLOGICAL SURVEY

After the U. S. Atomic Energy Commission was established by the Atomic Energy Act of 1946, the Commission asked the Geological Survey to make geologic and hydrologic investigations of several areas, including those of the Hanford Operations Office and the Los Alamos Scientific Laboratory. The work was broadened later and the Survey has furnished to the Commission information about the geology and hydrology of more than 60 potential sites for nuclear reactors, nuclear laboratories, and other facilities.

Site and Area Studies

Sites for facilities of the Atomic Energy Commission have been chosen by the Commission partly on the basis of preliminary descriptive site-feasibility reports by the Geological Survey. These reports contain information about water supply and geologic and hydrologic factors that would affect the construction, maintenance, and operation of the facilities, as well as the disposal and storage of liquid and solid waste to surface and subsurface environments. In addition, the Survey has made numerous studies of specialized problems.

By 1949 the Survey was making field studies for the Atomic Energy Commission in areas which included, among others, the sites of the following principal facilities:

1. Brookhaven National Laboratory, Upton, N. Y.
2. Knolls Atomic Power Laboratory, Schenectady, N. Y., and West Milton, N. Y.
3. National Reactor-Testing Station, near Idaho Falls, Idaho
4. Argonne National Laboratory, near Chicago, Ill.
5. Hanford Atomic Products Operation, Hanford, Wash.
6. Los Alamos Scientific Laboratory, Los Alamos, N. Mex.
7. Oak Ridge National Laboratory, Oak Ridge, Tenn.

At most of these places work by the Geological Survey has continued to the present time on special problems.

The amount of work has increased steadily, and in fiscal year 1957 the Geological Survey revised its organization facilities and program for these studies. More than 100 technical reports and many special memorandum reports have been prepared for the Atomic Energy Commission, and a number of specialized papers and reports have been published in scientific journals.

With increasing use of the environment, studies must be more intensive at the same time that their scope is broadened. Each disposal site is an individual problem which must be studied with respect to (a) the nature of the waste that will be discharged, and (b) the specific nature of the environment. The problem becomes regional, moreover, as the number of installations increases, and each problem and each area must be studied in relation to others. Detailed information must be obtained about the movements of liquids through porous earth materials, about the reactions between the liquids and the materials, and about the behavior of radioactive materials in surface water. Especially, we must learn more about the ultimate fate of specific isotopes in water and in the ground in terms of time, space, and possible harm to living things.

Current Field Projects

Beginning July 1, 1957, and continuing this fiscal year, the Geological Survey program of work in geology, water supply, and waste management included work and reporting for the Atomic Energy Commission in the following three areas, in addition to the seven listed above:

1. Connecticut Aircraft Nuclear Engine Laboratory, near Middletown, Conn.
2. Savannah River plant in South Carolina, near Augusta, Ga.
3. Georgia Nuclear Aircraft Laboratory, near Dawsonville, Ga.

Basic information about the geology, hydrology, and geochemical environment is a prerequisite for the wise choice of sites for nuclear-energy facilities. It is also the starting point for specialized and advanced studies of operational problems that arise at these facilities, especially storage and disposal problems and the natural safeguards that exist in the environment. The Survey program, therefore, has stressed the completion of basic studies, which are summarized below.

Sites of Principal Facilities

The Survey has made a comprehensive study of the geology and hydrology of the Brookhaven area. It has also made geologic and hydrologic studies near Schenectady, N. Y., and at West Milton, N. Y., including a tracer study on the Mohawk River at the Knolls Atomic Power Laboratory. The principal findings of this study are described in a paper by Simpson and others (1958). A study of the West Milton area and a brief field study of the geology and hydrology of the site of the Connecticut Aircraft Nuclear Engine Laboratory were completed recently.

Work on the geology and hydrology of the Argonne National Laboratory area has furnished information applicable to numerous problems, including water supply, foundations for building structures, possibilities for the disposal of low-level waste, and expectable movement of solutions if any are spilled accidentally.

General studies at Los Alamos, N. Mex., which concern the geology, hydrology, water supply, and waste management have been completed. Further specialized work is in progress in the Los Alamos area.

Extensive studies of the geology and hydrology of the National Reactor-Testing Station have developed a considerable amount of information about the quantity and quality of water available, foundation conditions for construction, sources of raw materials for construction, and factors that are pertinent to problems of low-level radioactive-waste disposal and the evaluation of the hazard from storage of high-level materials. The entire Testing Station is underlain by permeable volcanic rock, which is host to a very large body of ground water. Studies are under way to determine the velocity and direction of movement of the ground water and the fate of radioactive materials that get into the ground by design or accident. This is the most intensive areal study of the geology and hydrology of reactor sites that has been undertaken by the Geological Survey for the Atomic Energy Commission.

Studies by the Geological Survey on the geology and hydrology of the Hanford area have been completed, but the Survey will continue to be available for consultation and work on geologic, hydrologic, and waste-disposal and storage problems.

Past work by the Geological Survey at Oak Ridge National Laboratory consisted chiefly of studies of the geology and hydrology of the Oak Ridge area, including study of surface streams in the vicinity. Specialized investigations are continuing, including studies of the diffusion and dispersion characteristics of dissolved and suspended materials in the Clinch River, Tenn., and in natural streams generally.

A study of the geology and hydrology of the Savannah River plant in South Carolina has been completed. The Survey is continuing to make observations on the hydrologic conditions and will continue to be available for consultation and work on geologic, hydrologic, and waste-handling problems at that plant. For example, warm water discharged to the Savannah River system raises the temperature of the river water somewhat. Continuous records of water temperature and river stage have been obtained at two locations on the Savannah River and at one place on Lower Three Runs, a tributary of the Savannah into which water from the plant is discharged. Complete records of river discharge are being collected at one place on the Savannah River. Periodic measurements are made at one other place.

General work on the geology and hydrology of the site for the Georgia Nuclear Aircraft Laboratory, near Dawsonville, Ga., has been completed, but specialized study of the geology and hydrology is continuing.

Storage of Waste in Geologic Environments

Several kinds of geologic environments seem to offer possibilities for the containment of high-level wastes. Among these, two seem more promising at present: (1) storage in formations of natural salt; (2) storage in deep permeable formations in which natural conditions would prevent migration of the waste. Special study groups of the American Petroleum Institute (Moore, 1958) and the National Academy of Sciences (Hess, 1957) have recommended that studies be made of the possibilities for storage of wastes directly in geologic environments. Problems attendant upon injection in deep permeable formations are numerous: possible plugging of deep injection wells; plugging of pore space and loss of permeability in the ground due to chemical reaction between the earth materials and the injected liquid; corrosion of well casing by waste liquid; rate of heat dissipation and chances for boiling and geyser action in injection wells; the effectiveness of the geologic environment as a trap to contain the waste liquid for hundreds or thousands of years; and other problems. Study along these lines by the Geological Survey, Oak Ridge National Laboratory, and the Universities of California and Texas has been supported by the Atomic Energy Commission.

A theoretical study has been made by the Geological Survey of problems attendant upon injection of wastes into deep-lying permeable formations, and preliminary reports have been published (Roedder, 1957 and 1958).

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Among the geologic environments available for high-level waste disposal, natural salt deposits seem to be promising. Therefore, as part of its work in cooperation with the Atomic Energy Commission, the Geological Survey has made a special nationwide study of salt deposits. Salt is readily soluble in water, and salt deposits generally can exist at or near the land surface only in very dry climates. The occurrence of salt at depth is independent of present climates. Because salt deposits are dry, impervious, and do not fracture, radioactive wastes might be stored and contained indefinitely in them.

Salt is plastic (flows under pressure), so it is self-sealing. That is, it contains no free openings at depth, because these are sealed by plastic deformation. Because of these favorable properties, salt has been studied more than any other geologic material as an environment for waste diposal.

Salt is widely distributed in the United States, and deposits occur in at least 23 of the 49 States. If disposal in salt beds is feasible, therefore, it may be possible to locate disposal sites near power reactors and chemical processing plants. For that reason the Geological Survey has compiled summary information about the geologic occurrence, distribution, thickness, and depth below the land surface of all the known rock-salt deposits in the United States.

The principal salt deposits, some of which underlie thousands of square miles and have aggregate thicknesses of hundreds of feet, occur (1) in the Northeast, in parts of Michigan, Ohio, West Virginia, Pennsylvania, and New York; (2) southern Florida; (3) the southern midcontinent in Arkansas, Texas, Louisiana, Mississippi, and Alabama; (4) the High Plains of Texas, New Mexico, Colorado, Oklahoma, and Kansas; (5) the Williston Basin of the Dakotas and Montana; (6) the Paradox Basin of Utah and Colorado; (7) and the Supai Basin of Arizona and New Mexico. Smaller occurrences are known at many other places.

More than 24 million tons of salt is produced annually in the United States, but our reserve of salt is so stupendously large that it is essentially inexhaustible. Therefore, the use of carefully chosen salt deposits for disposal sites probably would not deny to us salt that would be needed in the future.

Storage of liquid in salt beds is not a new or untried idea. In the last six years mining and oil field operations have created more than 28 million barrels of storage capacity for petroleum products, chiefly in salt deposits.

Mined space in such rocks as shale and chalk costs about $3.00 to $7.00 per barrel of capacity to create. Space in salt is formed much more cheaply---$1.00 to $2.00 per barrel of capacity, because it can be created simply by dissolving the salt with water. In contrast, above-ground storage of waste in steel tanks costs on the order of $20.00 per barrel of capacity.

The Atomic Energy Commission expects to complete a test of a salt formation during fiscal year 1959, using nonradioactive liquid waste. The search will continue for a locality suitable for experiments with radioactive liquids. Selection and use of the site will be guided in part by information provided by the Geological Survey.

Meantime, the Geological Survey has completed the first phase of a study on the physical properties of natural salt (halite), anhydrite, and gypsum.

CONTINUING PROGRAM

Each place of release of radioactive material constitutes a unique case because each local environment differs in the characters of its climate, soil, water, and geology. In order to evaluate the safety of proposed operations at specific sites and their effects on the environment, criteria must be developed for controlling the dispersal of water and for establishing safe limits for the amount and kind of radioactivity to be released in the specific environment concerned.

Site Studies

Preliminary geologic and hydrogeologic studies have been made of several reactor sites, and more thorough studies of a few. Most of them need further study.

Basic general geologic and hydrologic information is the starting point for practically all advanced and special studies. Therefore, in addition to the kinds of site studies previously made, a general geological study and map and a general hydrologic survey and maps should be made for each important site. In those areas where high-level mobile wastes are or would be produced or stored, thorough studies should be made of the ground-water and streamflow regimens and of special features of the hydrology.

Hydrogeologic studies will continue at the sites of existing and proposed reactors and other facilities. Experience shows that thorough knowledge about each site is essential, for both immediate and long-term problems, especially sites that will produce or process high-level waste. Furthermore, this work must be accelerated greatly in order to catch up with the expanding nuclear-energy industry. Thus far, neither the Geological Survey nor the Atomic Energy Commission has been able to finance this work at anything approaching a desirable degree of intensity.

Research and Development

The Geological Survey has done considerable research and development along specialized lines, largely in connection with the evaluation of hazards from the storage and release of radioactive materials in natural environments. Continuation and expansion of much of this work is proposed, as indicated in the following section of this paper, so the accomplishments will not be described separately here. Certain specialized work in support of field projects, however, can be noted without repetition.

In connection with waste-disposal studies, the laboratories of the Geological Survey supported field projects with services in sedimentary petrology, mineralogy, and petrography. Nearly five hundred samples of natural earth materials were studied for clay-mineral identification, ion-exchange capacities, and mechanical composition. These samples came from Oak Ridge, Tenn., the National Reactor Testing Station, Idaho, Livermore, Calif., Los Alamos and Sandia, N. Mex., Hanford, Wash., Argonne National Laboratory, Ill., and the Savannah area, Ga.

Petrographic studies were made of sintered samples of fixed-waste solids produced at Oak Ridge and formed from heated masses consisting of simulated high-level waste mixed with shale, limestone, and soda ash. A chemical study was made of interactions between synthetic wastes and numerous natural minerals that might be encountered by radioactive waste if it is disposed of underground (see Roedder, 1957). This work has led to a series of about half a dozen highly specialized scientific papers in process for publication.

During fiscal year 1959 further geochemical studies are in progress on waste-management problems, and specialized work is under way on the development of techniques and instrumentation. Examples are the development of rapid methods for detecting trace amounts of strontium in natural water by emission spectroscopy. A special survey was begun of the physical properties of natural rocks, including their density, thermal expansion, compressibility, elasticity, internal friction, velocity of transmission of seismic waves, strength, plasticity, viscosity, melting temperatures, specific heat, heat of fusion, thermal conductivity, and magnetic and electrical properties. The rock types included are halite (salt), gypsum, anhydrite, granite, basalt, sandstone, shale, limestone, and dolomite.

Research and Basic Studies

In addition to field studies and reporting on the geology, hydrology and waste-containment problems of areas containing reactors and laboratories, the Geological Survey is doing important research in the field and laboratory and is carrying on basic studies that bear directly on waste disposal and the behavior of radioisotopes in the ground. Some of this work, as in fluid mechanics and heat potential, has been under way for some time, and some was started in fiscal year 1959. Among the more important topical projects of the Geological Survey that are related to the atomic-energy industry are the following:

1. Vertical movement of water through unsaturated earth above the water table.
2. Movement of water through permeable earth in the zone of saturation.
3. Electrical-analogue model studies and computing.
4. Heat potential of waste material injected or stored at depth underground.
5. Disposal of low-level waste by dispersal in surface streams.
6. Transportation and distribution of sediments in streams.
7. Mechanics of diffusion in streams.
8. Transportation of contaminants through long reaches of streams.
9. The occurrence of stable strontium in natural water.
10. Geochemical and geophysical studies.

11. Regional possibilities for the disposal or containment of radioactive waste on the land or in the ground.

12. Geologic and hydrologic criteria for the management of radioactive materials.

Vertical Movement of Water Above the Water Table

Radioactive solutions may be dumped on the ground accidentally or disposed of purposely in infiltration pits where they can seep into permeable earth materials. Beneath the land surface and above the water table the movement of liquid that enters permeable ground is chiefly directly downward. The ground can hold much water as soil moisture, but when the amount of water available exceeds the soil-moisture capacity, the excess moves down to the water table. The nature and speed of movement and the chemical changes that occur in the ground bear directly on the waste-disposal problem. At several important nuclear-energy installations there is a thick nonsaturated zone above a deep water table. Similar conditions probably will prevail at additional sites in the future. Where the water table is deep, waste liquid that is discharged to open pits at the land surface has a long downward path through which it percolates before reaching the water table. This affords an opportunity for natural decontamination of the waste by adsorption, ion exchange, and radioactive decay. Those who use such means hope that the radioisotopes will be retained in the rock above the water table, either permanently or until the activity has decayed.

Processes called ion exchange and adsorption have a chance to operate on waste liquids that enter the ground. That is, radioactive ions in the waste solution may be adsorbed (held by an electrical bond) on the surfaces of grains in the ground; or they may be exchanged for innocuous stable ions in the ground. The radioactivity of the waste solution has nothing to do with this process, which occurs whether the materials are radioactive or not. It is only a fortunate fact that the most dangerous radioactive isotopes are the kinds of elements that tend to be adsorbed or exchanged. The phenomenon is perhaps best thought of as a tendency of a water solution to come into chemical equilibrium with its solid environment. A waste liquid, when first discharged to the ground, is not in equilibrium with the ground environment. In the process of reaching equilibrium, it tends to lose some elements and pick up others.

Unfortunately, not all radioactive isotopes are removed by adsorption or ion-exchange. Ruthenium is especially prone to stay in the waste liquid. Also, the capacity of a column of earth to adsorb new elements is not unlimited. When that capacity is filled, the waste liquid is in equilibrium with the soil and passes through it unchanged.

At Hanford waste is discharged to a covered seepage pit or "crib" until the earth beneath it has taken up all the radioisotopes it can hold. When significant radioactivity is detected in the ground water through monitor wells, the pit is abandoned and a new one is dug.

The nature of movement of water beneath waste pits is an important factor in their operation. Where movement is rapid, opportunities for ion exchange are fewer than where it is slow. Also, the amount of spreading as the water percolates downward determines how big a volume of earth is effectively available for ion exchange. The facts about phenomena beneath the pits are important because they determine the volume of sediments available for ion exchange and the volume of earth material that becomes contaminated itself—essentially forever—in the process of decontaminating the percolating water.

The movement of water in natural sediments is complicated because natural earth materials are extremely variable in their composition, porosity, and sizes of grains. The principles that control the microscopic movement of water above the water table are being studied in laboratory experiments by the Survey. Many experiments will be needed to get definitive results.

Microscopic Flow Through Permeable Solids

Two sets of laboratory experiments have been established to investigate microscopic-flow phenomena of water through porous solids. One will use low-level radioactive tracers; the other will use ordinary chemical tracers. These experiments will permit detailed study of the way in which ground water moves and how much dilution by diffusion, mixing,and convection of waste liquids may occur. For example, study of the convective diffusion of a tracer material through porous solids will help to evaluate the feasibility of using radioactive tracers in the laboratory and in the field to determine the relative importance of the several natural factors that control ground-water movement.

Electrical Analogue Studies and Computing

It is difficult to compute the effects of pumping water out of a formation or the effects of putting water into it, because natural earth formations are very complex and heterogeneous. Mathematical equations that describe the movement of electricity through conductors also describe the microscopic flow of ground water through aquifers. An analogue model and computer have been built by the Geological Survey, using resistors, capacitors, and electrical current in electrical circuits that can simulate the conditions of permeability, storage capacity, and hydrologic boundaries of natural hydrologic systems. The computer analyzes the electrical properties of the simulated system and translates them into predictions of the behavior of water in the natural system. The effectiveness of the prediction is limited essentially only by the accuracy and detail of the field information that is available to be put into the computer. This is one of the most useful advances in hydrologic methods that has been made in recent years. It will have many specific applications in water problems, quite aside from problems of waste disposal.

Heat Potential of Radioactive Material Injected or Stored Underground

One problem in the underground storage of radioactive waste is the local rise in earth temperature caused by the heat emitted by fission products. Rock and soil are poor heat conductors. The heat from a large body of waste would not be conducted away as fast as it is generated; it would be stored up and would cause a continual temperature rise. This problem was reviewed in a paper by a Survey scientist at the 2d Nuclear Engineering and Science Conference in March 1957 (Skibitzke, 1957).

Disposal of Low-Level Waste by Dispersal in Surface Streams

During fiscal year 1958 the Geological Survey participated in temperature- and velocity-distribution studies of three streams to obtain information about the nature and limitations of diffusion and dispersion in natural stream channels. These observations were on the Clinch River, the Savannah River, and the Chicago Sanitary and Ship Canal. Miscellaneous data were obtained at other locations.

In fiscal year 1959 the Survey is making detailed studies of diffusion processes, following three avenues of approach: (1) mathematical expressions for diffusion are available and these will be adapted to open-channel flow with vertical velocity gradients, secondary circulation, and density gradients; (2) the mathematical investigations are supplemented by laboratory study to test certain assumptions and to identify factors which may be evaluated from the experimental data; (3) the results are tested with field experiments, and techniques will be developed for empirical determination of the diffusion characteristics of streams.

Transportation and Distribution of Sediment in Streams

Most isotopes that occur in the kinds of wastes that may be discharged to streams can be adsorbed readily on stream sediments. The movement of the adsorbed isotopes will depend on movement of the river sediments. Where sediments settle out of suspension and accumulate on river bottoms or floodplains, conditions may be potentially hazardous. In this way, activity that was diffuse when released may become concentrated.

Study of the transportation and distribution of stream sediments is a regular part of the Survey's program. Intensified work is needed, however, to define and evaluate factors that control the transportation rate and distribution of radioactive waste adsorbed by sediment in the water, along the bed and banks, and in the flood plains of streams. The study will evaluate the role of sediment in the control and movement of radioactive waste in surface waters and stream channels, and will indicate the contamination levels in flowing streams and flood plains. The study will be coordinated with research on ion-exchange phenomena through the collection and analysis of data on the relation of the concentration of radioactive wastes in the solutes to the concentration on sediment. Experiments will be done in laboratory flumes or small canals and in natural streams.

The first-year (1959) product of this study will be a progress report which will:

1. Review available literature and supporting new field work to define the problem.

2. Evaluate the extent to which existing data and current theory are applicable to the problem, and the requirements for new data and theory.

3. Assess possibilities for fundamental new laboratory and field experiments to develop principles that are directly applicable to specific field conditions.

4. Identify the streams that are hazardous or may become so because of the accumulation of radionuclides in river-bottom sediments.

5. Outline a program of further study in areas where the existing or potential hazard warrants investigation.

Mechanics of Diffusion in Streams

All nuclear-energy power plants require large amounts of water for cooling and it would be economical and convenient to return this water to surface drainageways. The water will contain some induced radioactivity and low-level contaminants. When this waste is released, or high-level waste is released by spill or accident, how will it be dispersed in streams? The waste water from most plants will also contain non-radioactive industrial contaminants, such as salt. The dispersal and behavior of this also must be understood.

The Geological Survey has completed the first phase of a study of applications of the theory of diffusion in natural streams to the study of behavior of waste materials in stream courses. Much remains to be done. The water velocity in a flowing stream varies both through its vertical and its horizontal cross-sections. Also, density currents are created by differences in the specific gravities of natural water and waste liquids. The complex forms of the channels of natural streams induce further complexities in the movement and dispersion of water.

Study of these problems is necessary to develop means for predicting how waste will behave as it moves downstream, and how it will affect the water supplies of downstream water users. Early studies will be made in the laboratory and in small natural streams, using chemical tracers. Later studies will include larger streams and tracers that can be detected readily in very small amounts. Studies would include turbulent flow, partly turbulent flow, laminar flow, and flow in tidal reaches of streams.

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Transportation of Contaminants Through Long Reaches of Rivers

The topical study noted just previously would define the initial or short-distance diffusion of contaminants, either from waste or fallout. That is, the study would give a picture of the process and effectiveness of mixing between waste and river water through a reach of the stream below the source of contamination. The physical transfer of the mixture, after diffusion occurs, by river flow through long distances also is a matter of concern. If waste were released at plant A, for example, when would it reach town X, 50 miles downstream? What would be the concentration at that point? How long would it take to pass by? The Survey has already done some work on this line in its regular program, and has developed procedures for making the calculations. The results of the work should have important applications in a national-defense emergency, because public water supplies of an entire mainstem drainage system might be contaminated by heavy fallout from an atomic attack. Therefore, the study will cover the principal river systems of the United States. The results will be applicable also to problems that would arise from accidental contamination of a stream. The study will include (a) the time of travel of water volumes along the mainstem of the principal river systems of the country, at selected stages and discharges; (b) the relation between the time of travel of water volumes and the time of travel of radioactive waste; (c) the removal of isotopes from water by adsorption on sediment and accumulation of contaminated sediments in river channels and reservoirs.

A method for calculating time of travel of water volumes has been developed and was tried on the Potomac River from Cumberland, Maryland, to Washington, D. C. The method is being further tested on the Ohio River from Pittsburgh, Pennsylvania, to Cincinnati, Ohio.

Occurrence of Strontium in Natural Water

Some of the dangerously radioactive isotopes do not occur in nature. Strontium is one of these. Its half-life is 28 years and the earth is so old that all natural radioactive strontium decayed long ago. Non-radioactive strontium, however, is relatively common and occurs in appreciable amounts in many surface waters and ground waters. The stable natural strontium in water will affect to some degree the biological metabolism of strontium-90, a fission product which is especially dangerous biologically. Organisms which take up strontium will ingest less strontium-90 if stable strontium is available also. However, little is known about the amount of stable strontium present in natural streams. Information is needed as a background for various studies that are being made of the effects of strontium-90 in the environment. Analyses are being made of water samples collected where the Survey is already obtaining information about other chemical constituents of water.

Geochemical and Geophysical Field and Laboratory Studies

The Geological Survey has done considerable laboratory work and research on special geochemical and geophysical phases of the waste-disposal problem. The more important current and planned activities concern the following topics:

1. Ion-exchange properties and mechanics of natural formations.

2. Reactions between simulated waste solutions and various earth material.

3. Thermal and elastic properties of salt and other earth materials.

4. Selective separation of cesium and strontium from simulated waste.

5. Conversion of liquid waste to relatively stable solids. This study is coordinated with others already in progress, sponsored by the Atomic Energy Commission, at other laboratories.

6. Research in the use of geophysical instruments to detect radioactive waste material in earth.

The results of ion-exchange studies are incorporated with various other related information when reports are prepared.

Experimental proof has been obtained that certain kinds of liquid wastes cannot be injected into permeable formations because chemical reactions will cause clogging of the formations. Either the wastes or the formations must be pretreated before injection. This information has been published (Roedder, 1957, 1958).

Study of the thermal and elastic properties of salt is part of the study of possibilities for storage of high-level waste by containment in natural salt beds. Whether the liquid would remain in place or would migrate depends on thermal, elastic and other properties of the salt.

Cesium and strontium are two of the more dangerous waste fission products. Much high-level waste could be reduced to intermediate levels by removal of cesium-137 and strontium-90. The problem of disposing of the main volume of waste thus would be greatly reduced.

Conversion of liquid waste to relatively stable solid form is one of the most promising methods for waste containment. Several non-Survey laboratories and institutions are working on this possibility. The Geological Survey approach is coordinated with others. The term "stable" is relative. In the chemical-laboratory sense, a solid is stable if it does not react or disintegrate appreciably in a short time. In the geochemical sense these solids may be only metastable—"half stable"—because they may react with the environment in what is a geologically short time. Inasmuch as high-level waste must be immobilized for centuries or millenia, depending on its composition, the solids must be "stable" in a geologic-time sense. The study, therefore, is a three-fold one: (1) conversion to solid form; (2) study of the solid and its possible geochemical reactions in the geological environment where it is to be stored; (3) choice of storage environments where reaction is least likely and would do the least harm.

Geophysical instruments and methods have numerous applications in waste-disposal problems. A specific example is radioactivity logging of proposed and existing waste-disposal sites. This kind of logging delineates the "background" (natural) radioactivity of sites that have not been contaminated, and the amount, distribution and nature of activity in areas where waste has been dispersed. The work includes identification of the sources of radioactivity. Considerable work is needed for further development, adaptation, and refinement of instruments and instrumental techniques.

Laboratory analytical support to other parts of the program consists of services in the following:

1. Sedimentary petrology, including specifically clay mineralogy, ion-exchange evaluations, and analyses of the physical composition of samples of earth materials.

2. Mineralogy and petrography, including identification of mineral and rock specimens and related kinds of work.

3. Chemical, mineralogic, spectrographic, and radiometric analyses of rock samples.

4. Study of the occurrence of trace amounts of rare-earth elements in soils and natural water, using chemical and spectrochemical methods.

The last-named study demonstrated for the first time the occurrence of quadrivalent cerium in soils, and the importance of reduction-oxidation potentials in the distribution of natural cerium.

Regional Possibilities for Disposal of Radioactive Waste on Land or in the Ground

An analysis is under way, based largely on published information, of the geologic, hydrologic and other physical characteristics of principal physiographic subdivisions of the United States and the possibilities in them for the storage or disposal of radioactive waste.

Maps and texts are being prepared to delineate, in each physical division of the United States, the types of rocks that are present at the surface and at depth, the position of the water table, the general course of movement of the ground water and its relative velocity, the main surface-drainage lines, and other geohydrologic factors bearing on waste disposal.

The preliminary study has been completed. Work on a comprehensive report and a report on one major physical subdivision, the Atlantic Coastal Plain, is under way.

Studies at Nevada Test Site

In a general sense, the Nevada Test Site is a waste-disposal area because the fission products from underground tests remain in the ground, and some of the products of ground-level and air bursts also reach and remain in the ground. No special danger is foreseen from the small amount of fission products in the test area, but their presence offers unusual opportunities for study of the behavior of fission products in the ground, and for their use as trace-elements for study of ground-water motion.

Survey scientists are working at the Nevada Test Site in collaboration with the Atomic Energy Commission. In November 1957 a study was begun of ground water in the test area, with special reference to the possibilities of contamination from underground nuclear explosions. The Survey is also collaborating in geophysical and engineering geologic studies at the Nevada Test Site.

SUGGESTIONS ABOUT WASTE DISPOSAL

Disposal of high-level liquid wastes by dilution and dispersal is not an acceptable general practice. Therefore, until a means for ultimate disposal by containment is found, the only realistic and safe procedure is to confine these wastes completely. The hazard from radioactivity is so great and so subtle that no important element of doubt should be allowed about safety. Therefore, no decision to discharge waste to the ground should be made until after consideration of the specific kind of waste, the specific nature of the environment, the probable reactions between the two, the relation of the disposal site to regional geologic and hydrologic factors, and the length of time the waste will remain hazardous.

The long-term feasibility and safety of waste disposal depend largely on geologic and hydrologic factors, so no single method is best for all wastes and all situations. The costs of various methods of containing or immobilizing wastes vary widely. Each method of disposal that has been proposed involves some risk of irreversible contamination of the human environment. The method finally chosen, therefore, must be one in which these risks are at a minimum. Otherwise, inescapable harm may be part of the price we pay for nuclear power. Therefore, the cost of preventing harm must be borne, even though it limits the use of such power.

Prudence, recognition and use of pertinent principles of geology and hydrology, along with reasonable expenditures of money probably can assure reasonable safety in waste management. The Geological Survey recommends that no disposal or management practice be employed if it creates any appreciable hazard whatever beyond the area occupied or reserved by a nuclear-energy facility. For hazards that would operate in and affect only the area occupied or reserved by the facility, more risk may be incurred than would be acceptable elsewhere. Premeditated risks may become necessary at some places, and if their nature and probable degree are known, preparation can be made to reduce the hazards if and when that becomes necessary. No risk should be accepted, however, without prior assessment of the damage that may occur and prior recognition of the size and location of areas that may be denied to occupation if contamination occurs.

In the case of low-level wastes that are discharged to the environment, several means for dilution should be considered: dilution before disposal; dilution in the soil by soil water; dilution by ground water; dilution by surface water where contaminated ground water is discharged into surface streams; dilution by surface water where the waste is discharged directly to streams. As a matter of policy, dilution by ground water and surface water should be regarded primarily as safety factors. In the absence of quantitative data these factors should not be relied on as primary means for making water safe for use. The final goal of waste disposal should be (a) to contain or immobilize permanently all dangerous amounts or levels of activity; (b) to assure that where dangerous activity is released it will be retained permanently in the ground above the water table; (c) to assure that innocuous wastes do not become concentrated to dangerous levels after they are released.

Areas where earthquakes are frequent, even though they are minor in magnitude, should not be considered for the storage or containment of high-level waste, especially in areas where faulting of geologic structures is extensive, and especially if fault movements have occurred in geologically recent time. Fault structures make it difficult to predict the course and rate of fluid migration, and a disposal system may be unstable in a faulted, seismically unstable district.

CONCLUSIONS

Unwise waste-disposal practices or a single accident could contaminate many billions of gallons of water and many square miles of area. The population and development of the United States inevitably will require complete use of all its water resources in the foreseeable future. None of our water can be spared. The kinds of areas where nuclear-energy facilities are apt to be installed are areas in which water supplies are short already or may become so in the early future. Water supply may be the limiting factor in the development and tenure of these areas, so we cannot afford to risk destruction of the utility of any water supplies.

With continued population growth and economic expansion, land area and mineral resources also will be at a premium. We cannot afford to convert usable land to radioactive wastelands.

Absolute safety is unattainable in any industry. Because of the subtlety of radioactivity and the long time through which radioactivity contamination endures, however, the hazards in the nuclear-energy industry exceed those from others, and they must be reduced to the lowest feasible level.

Nuclear-energy facilities can be constructed by private agencies only with Governmental permission. Therefore, the Government is responsible to assure minimum operational hazards. To do so, the Government should require that waste handling and disposal methods at any given site be adapted to the physical environment at that site. Such adaptation can be achieved only by adequate advance study of the environment and evaluation of it in relation to the specific facility that is proposed. The experience and knowledge of the Geological Survey will enable it to contribute substantially to solution of development and waste-management problems and to the reduction of hazards.

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STATUTORY RESPONSIBILITIES OF THE ICC WHICH PERTAIN TO THE TRANSPORTATION OF RADIOACTIVE WASTE MATERIALS

By

Kenneth H. Tuggle, Chairman,
Interstate Commerce Commission

Kenneth Herndon Tuggle took the oath of office as an Interstate Commerce Commissioner September 8, 1953, to complete a term expiring December 31, 1954, and was reappointed January 15, 1955 for a term expiring December 31, 1961. He has been Chairman of the Commission since January 1, 1959, and will continue to serve in that capacity until the end of the calendar year.

He was born at Barbourville, Kentucky June 12, 1904, the son of Judge Jesse D. and Sue Gregory (Root) Tuggle. He attended the Colleges of Arts and of Law at the University of Kentucky, graduating in 1926.

Admitted to the Kentucky Bar in 1926, he maintained a private law practice from then until his ICC appointment in 1953. In 1934 he organized the Union National Bank at Barbourville and was Chairman of its Board until 1953. He also was a director of gas, manufacturing and lumber companies.

From 1943 to 1947 Mr. Tuggle was Lieutenant Governor of Kentucky, serving as acting Governor of Kentucky for three months of the term, as Chairman of the Kentucky Legislative Council in 1943 and 1945, and as President of the State Senate in 1944 and 1946.

Mr. Tuggle was a member of the Kentucky Committee on Interstate Cooperation from 1944 to 1948; member of the Board of Managers of the Council of State Governments from 1944 to 1947; Chairman of the Kentucky Disabled Ex-Service Men's Board from 1943 to 1947; member of the Kentucky Committee on Resources and Functions of State Government from 1950 to 1952; and a member of the executive committee of the Kentucky Bookmobile Project from 1952-1956.

He is a trustee of Union College, served as Colonel in the Kentucky Active Militia during World War II, and is a member of the American, Federal, Kentucky and Knox County Bar Associations, the American Society of Traffic and Transportation, the American Judicature Society, the Federal Safety Council, Sons of the American Revolution, Pi Kappa Alpha, Omicron Delta Kappa, Masons and Elks. He was Chairman of the Delegation representing the United States Government at the 6th Session of the Inland Transport Committee, I.L.O., Hamburg, Germany in 1957.

The Commissioner is married to the former Miss Vivian Shifley and has two children -- Kenneth Jesse, a student at Yale, and Sarah Baldwin Tuggle. He is a Methodist and maintains his home at 5302 Elliott Road, Washington, D. C.

As Chairman of the Commission he is also ex officio chairman of the Commission's Committee on Legislation and Committee on Rules. He has served as a member and chairman of Division 1, the motor carrier division, and as chairman of Division 3, Rates, Safety and Service. Just prior to becoming Chairman the Commissioner was in administrative charge of the National Defense Executive Reserve Unit of the ICC and also in administrative charge of its Transport Mobilization Staff until it was inactivated.

The aspect of the industrial radioactive waste disposal problem with which the Interstate Commerce Commission is primarily concerned is, of course, the safe transportation of such materials. Under the Federal statutes commonly known as the Transportation of Explosives Act (18 U.S.C., secs. 831-835) and section 204 of the Interstate Commerce Act (49 U.S.C., sec. 304), the Commission has prescribed regulations governing the safe transportation of radioactive materials in interstate commerce. These regulations, first prescribed in 1947, are applicable to rail and motor carriers and to shippers using those services and the services of the water carriers. They are published in the Code of Federal Regulations (49 CFR Parts 71 to 90 and 190 to 197), and in the cumulative pocket supplements thereto. Additions and changes therein are also published in the daily Federal Register at or about the time of their adoption. While the Commission's jurisdiction in this connection does not extend to carriers by air or water, its requirements in this respect do form the basis of regulations prescribed by the Civil Aeronautics Board for air carriers and the users thereof and by the United States Coast Guard for water carriers.

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The regulations initially adopted by the Commission were based upon studies and recommendations made by a subcommittee of the National Research Council during the early stages of atomic development. Since much of this development was of a highly secret nature, it was essential for the Commission to limit its requirements accordingly so as not to interfere with or hinder defense efforts, many of which are still carefully guarded secrets. Broad exemptions were granted to the Atomic Energy Commission and to the military departments in order to allow their functions to proceed without undue interference since they possessed knowledge of the implications. These exemptions were also granted and, to a large extent, are still continued because of the assurances given to the Commission that the fullest precautions would be taken to prevent accidents. Because of the secrecy surrounding the activities and methods of those agencies, it was, of course, also necessary for them to assume the responsibilities attendant to the proper packaging, marking, stowage, and all other obligations incidental to the transportation of exempt shipments.

The procedures followed by the Commission in developing and adopting regulations governing the transportation of radioactive materials are the same as those used in the formulation of regulations for the transportation of all dangerous articles. Experts in the particular field study the needs and make

recommendations which they believe to be in accord with the best known practical means of providing reasonable safety in transport channels. The Commission thereafter studies the recommendations and publishes those found suitable in a public notice of proposed rule-making. Reasonable time is allowed for the general public to comment thereon and if no serious objections are received an order is entered adopting the proposals. All reasonable objections are given full consideration and proper adjustments are made before any of the proposals are adopted by the Commission.

Under the Commissions's regulations, radioactive substances are classified as Class D poisons pending enactment of an amendment to the Transportation of Explosives Act making specific provisions for such materials Present regulations limit shipments to 2,000 millicuries 9/ of radium, polonium, or other members of the radium family, and not more than 2,700 millicuries (disintegration rate of 100,000 million (10^{11}) atoms per second) of any other radioactive substance in one outside container for shipment by rail freight, rail express, or highway, except by special arrangements and under conditions approved by the Bureau for the Safe Transportation of Explosives and Other Dangerous Articles of the Association

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9/ For the purpose of the I.C.C. Regulations one millicurie is that amount of any radioactive material which disintegrates at the rate of 37 million atoms per second. (One thousand millicuries is equal to one curie).

of American Railroads 10/, or except as specifically provided elsewhere in the Commission's regulations. Some special arrangements are also permitted under approved conditions, while those offering little or no hazard to carrier personnel are exempted when packed and marked as outlined in the regulations. The Special Permits issued by the Commission or the Bureau of Explosives of the AAR set forth detailed provisions as to containers, mode of carriage, volume, or other pertinent facts necessary to insure reasonably safe transportation of the material.

From the standpoint of safe transportation, the radioactive waste disposal problem was, until quite recently, relatively insignificant because disposal from Government operations was generally a local proposition. However, since the enactment of the 1954 amendment to the Atomic Energy Act, which opened the door to the development of atomic energy for peaceful purposes, the waste disposal problem has increased considerably. While some shipments of radioactive waste materials can meet the requirements of existing regulations,

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10/ The Bureau of Explosives of the Association of American Railroads is authorized by the Commission to pass on requests to transport amounts in excess of those stated above. It also drafts permits stating the conditions under which such shipments may be introduced into transport channels, depending upon the materials, containers, or methods involved in each particular instance. About 550 such permits have been issued.

to a large extent the transportation thereof from plant to plant or to disposal areas has been accomplished under Special Permit. There appears, however, to be a growing tendency to reduce the cost of packing these materials, which may consist of solids, liquids, gases, and contaminated articles (contaminated articles being anything from floor sweepings to clothing, tools, and machinery or building materials, each requiring different methods of disposal).

A considerable portion of the transportation of industrial radioactive waste is now performed by motor vehicles. Tractor-semitrailer combinations are used principally when such materials move long distances by highway. The distances over which they are transported are often considerable, radium waste being transported from eastern Pennsylvania to points in California and other such substances being transported from the midwest to the east coast. The material normally is shipped in drums, subject to limits on surface radiation as prescribed in the regulations. However, because of efforts by shippers to reduce transportation costs, some Special Permits have been issued by the Commission authorizing departure from the limitation of 40 units of radioactive material which may be transported in any one vehicle as specified in existing regulations.

In issuing such Special Permits particular care has been taken to provide requirements for maximum radiation at specified

distances from the sides and ends of the vehicle. Provision has been made for specific limitation of gamma radiation, or equivalent, at a distance of 12 feet, from any surface of the motor vehicle, and at a distance from 5 feet from either end. A requirement has also been incorporated that the driver shall be adequately protected or shielded.

Such permits contain limitations as to the duration of stops and the number of stops which may be made en route, with the provision that during such stops the vehicle must not be left on a public highway. Accidents, or unforeseen delays, are required to be reported immediately to the shipper to enable it to provide adequate supervision and instruction. The vehicles are also required to be placarded in order to alert police and fire authorities of the nature of the cargo in case of fire.

It should also be pointed out that some waste material shipments consist of substances, such as radium waste, for which the Atomic Energy Commission has no responsibility or jurisdiction. These materials are often shipped by firms not subject in any sense to AEC control. As the volume of such shipments, together with materials from AEC installations and those of AEC contractors, increases, study must be made of the need for keeping the regulations of this Commission effective. Among the safeguards with respect to

which there is a need for more adequate information are those relating to possible contamination of vehicles and other lading in such vehicles, the need for protection of the public while the vehicles are stationary, questions relating to limitations on time of storage while en route, and the possible need of metering devices or other measurement methods to be carried on such vehicles. Further study should also be given to the need for more frequent physical examinations of drivers who operate vehicles transporting such shipments. In all these areas of inquiry the Commission seeks and obtains the advice of the AEC and the Department of Health, Education and Welfare.

Aside from the deep interest in industrial developments of radioactive substances, and atomic energy, it has been noted that many States have also been active in providing health controls in the many aspects of these operations. The magnitude of the problem, in its many phases, is one where the broad experience and special knowledge of the Atomic Energy Commission can be most useful to the regulatory agencies so that adequate but reasonable standards can be devised as well as a reasonable degree of uniformity attained between state, national and international requirements. Otherwise each must make independent studies and decisions which may interfere with the interchange of shipments. With respect to international requirements it should be noted that Canada adopts the regulations of the

Interstate Commerce Commission and all amendments thereto on a current basis, thereby providing a uniform system between the two countries in this connection.

In view of the many advances which have taken place in the atomic field in recent years and the opportunities now open for private development, there appears to be a real need for an overall review of present practices so that more complete and informative regulations may be drawn. At the completion of the Committee's hearings the Commission will undoubtedly be in a better position to know what steps to take toward that end.

Copies of the Commission's regulations are not being submitted herewith for the record because of their great bulk and for the further reason that copies, or pertinent portions thereof, were recently transmitted to the Committee in connection with the preparation of a survey and report by its staff on the subject of "Federal - State Relationships in Regulating Radiation Hazards".

It is hoped that the foregoing discussion will be of assistance to the Committee in its consideration of this important problem.

BUREAU OF MINES ACTIVITIES RELATED TO RADIOACTIVE WASTE DISPOSAL

By
R. A. Hardy, Asst. Secretary of the Interior

The introduction of highly radioactive wastes into the earth's surface will have distinct bearing on the conservation and development of the Nation's mineral resources; thus, the underground disposal of such waste products is related to the Bureau of Mines' interests under its Organic Act (Public Law 386).

The duties of the Bureau of Mines, as provided in the Act, include increasing safety, improvement of health conditions, and prevention of waste in the mining and metallurgical industries, as well as the investigation of mineral fuels with a view to their most efficient treatment and use. Therefore, as a functional responsibility, this agency can assist in a comprehensive research program relating to the engineering practices and procedures for safe and economical underground disposal of highly radioactive wastes and for determining feasible and economic methods of recovering any valuable elements and compounds which may be present in the wastes.

Engineers and scientists from the Bureau have attended annual information meetings on radioactive wastes and health physics and also have inspected current storage and disposal systems of Oak Ridge, Hanford, and other nuclear sites. Members of the staff have represented the Bureau on waste disposal study groups, including the recent American Petroleum Institute advisory committee to the Atomic Energy Commission on deep-well disposal. As a result of our activities, we find that many technical and economic aspects of radioactive waste disposal are similar to those considered by the mining and petroleum industries in their operations.

The deep-well method for disposal of radioactive liquid wastes involves their injection into geologic formations resembling those from which petroleum is produced. Also, suggested techniques for the injection of the liquids have much in common with current methods for secondary petroleum recovery and underground gas storage. Consequently, work presently underway at the Bureau of Mines' Petroleum

Experiment Station, Bartlesville, Oklahoma, on radioisotope tracing of subsurface waterflood patterns, conditioning injection waters, reservoir studies, techniques for cleaning and reconditioning wells, brine disposal, and aqueous corrosion constitute a firm basis for research on parallel problems inherent to the subsurface injection of radioactive wastes. The Bartlesville station is adequately staffed and equipped with the latest field and laboratory research facilities, including fixed and mobile radioisotope tracer instrumentation.

Any procedures developed for storage of liquid and solid radioactive wastes in salt mines and cavities will embrace research on mining, rock mechanics, and other intimately associated subjects. The experience of the Bureau in the design of underground rooms for special purposes and in determining the costs incurred in the preparation of such chambers should be invaluable in this program. The Bureau of Mines' Applied Physics Laboratory, College Park, Maryland, carries out research on heat transmission, fluid migration, plasticity of rock, and closely aligned subjects which must be studied before the salt disposal system can be determined sound.

On behalf of conservation, the Bureau can develop procedures for the metallurgical and chemical treatment of aqueous wastes to extract stable and radioactive materials of possible value to industry and to produce a solid which is less dangerous and more amenable to storage. The most practical and economical method of fixation and the possible subsequent recovery of specific elements from the stored solids should be considered. The marketability of products from the wastes would reduce the costs of ultimate disposal and would assist in achieving competitive nuclear power.

In any investigations on the disposal of radioactive wastes in which the Bureau participates, it will continue its long-established policy of cooperation with the Atomic Energy Commission and with other Government agencies, State groups, industry, and universities having a vested interest in all or any part of the program.

Regulation of Disposal of Radioactive Wastes

By
Dr. Edwin P. Laug, Bureau of Biological and Physical Sciences, Food and Drug Administration.

Born October 4, 1902 - Philadelphia, Pennsylvania

Graduate of Haverford College, Haverford, Pennsylvania

AB in Chemistry, 1925
AM in Chemistry, 1926

University of Pennsylvania, Philadelphia, Pennsylvania,

PhD in Physiological Chemistry 1930

Instructor in Physiology, University of Pennsylvania Medical School 1930 - 1933

Fellow in Nutrition Research, Department of Chemistry University of Tennessee 1933 - 1934

Research Associate in Physiology, Department of Physiology, University of Pennsylvania 1934 - 1935

Appointed Assistant Pharmacologist, Food and Drug Administration, Division of Pharmacology 1935

Promoted to Associate Pharmacologist 1936

Promoted to Pharmacologist 1937

Particular experience in development of chemical methods for analysis of heavy metals in food and toxicology of such substances. Since December 1952 he has been Chief of the Physiochemistry Branch of the Division of Pharmacology, of the Bureau of Biological and Physical Sciences of the Food and Drug Administration participating in and directing studies in problems associated with radioactivity as contaminants in foods and drugs.

The Food and Drug Administration is responsible for the enforcement of the Federal Food, Drug and Cosmetic Act. This Act, among other things, is designed to prevent the distribution of foods containing or contaminated with dangerous, harmful, and deleterious substances, as well as unsafe drugs and cosmetics. Unforeseeable and accidental contamination of food with dangerous substances is prohibited under a section declaring food adulterated if it bears or contains any poisonous or deleterious substance which may render it injurious to health.

Foreseeable additions to food which result in substances not known to be safe are regulated by affirmative authorizing regulations specifying authorized conditions of use and maximum quantities permitted. Radioactive material is specifically included by statute. The Food Additives Law (P.L. 85-929) also provides that no additive shall be deemed to be safe if it is found to induce cancer when ingested by man or animal or if it is found after tests which are appropriate for the evaluation of the safety of food additives to induce cancer in man or animal.

It is the obligation of the Food and Drug Administration to enforce these laws in all transactions affecting interstate commerce. State laws applicable to intrastate commerce are generally patterned after the Federal law. P.L. 85-929 passed September 6, 1958 has not yet been generally adopted by states. The Food and Drug Administration maintains the Division of Federal-State Relations to cooperate with and receive cooperation from State officials in law enforcement.

Contamination of the food, drug or cosmetic supply from radioactive wastes would bring such commodities into violation of the law both by radioactive material becoming components of such commodities and, in the case of foods, by affecting the characteristics of the food even where there is no continuing radioactivity present. The Federal Food, Drug and Cosmetic Act applies to imported commodities as well as to domestically distributed commodities and to commodities exported from the United States. In seeking to establish a basis for dealing with the possible problem of contamination with radioactivity generally, and to deal with problems of contamination from radioactive wastes if it occurs, the Food and Drug Administration has for a period of years been engaged in establishing basic data of normal background radioactivity in foods. A very substantial amount of specific data on the normal radioactivity of foods has been developed by the analysis

of products that were packed and prepared prior to the beginning of experimental atomic explosions in the United States. There has been a continuing program of adding to this data on products packed from year to year in order to ascertain any trends of increase of radioactive contamination. A continuing program directed primarily at certain products which show the greatest amount of radioactivity is carried on. This includes attention to domestic and imported foods. Significant expansion of this coverage of the food supply to insure its safety will be necessary.

Up to the present the disposition of radioactive waste material has not been the problem, but rather the problem of contamination by radioactive material from any and all sources. It is, of course, imperative that in any program of industrial utilization of radioactive material which involves the waste disposal problem, that every possible safeguard be employed to avoid contamination of the food supply at all. As the program develops through the installation of such industrial facilities, provisions must be made for extensive expansion of equipment and personnel to adequately cover the problem and insure the protection of the public health. The present facilities of the Food and Drug Administration for this work are sharply limited.

The problem of tolerance or maximum permissible levels for either accidental or foreseeable contamination is a complex and troublesome one. It can readily be seen that this problem is further complicated by the "cancer clause" of the Food Additives Amendment (P.L. 85-929) that would apparently be applicable to radioactive contamination.

Submitted By Clarence G. Morse, Administrator,
Maritime Administration,
U. S. DEPARTMENT OF COMMERCE

BORN: Jennings, Louisiana - February 7, 1904

EDUCATION: University of California - B.S. 1926; LL.B. 1928

BACKGROUND: Attorney, self-employed, general civil practice, at Oakland, California, mid 1928 to end 1928
Attorney, general civil practice, firm A. B. Bianchi, San Francisco, California, 1929 to 1934
Attorney, general civil practice, specializing in admiralty law, firm Graham and Morse, San Francisco, California, from September 1934 to June 13, 1954
General Counsel, Federal Maritime Board and Maritime Administration, Washington, D. C., June 14, 1954 to March 18, 1955
Nominated to Federal Maritime Board by President Eisenhower on March 4, 1955, confirmed by Senate on March 14. He was designated by the President as Chairman of the Board, and automatically became Maritime Administrator. He was sworn into office March 18, 1955. His appointment was to serve the remainder of the term of Louis S. Rothschild, expired June 30, 1956
He was reappointed by the President at that time to serve a full term of 4 years, expiring on June 30, 1960

Member of State Bar Association of California
Member of San Francisco Bar Association
Member American Bar Association
Member Maritime Law Association
Admitted to practice before Supreme Court of the U. S. in 1947

Married Susan Kyler Morse, Oakland, Calif., June 25, 1927;
Divorced at Reno, Nevada, July 25, 1947

Two daughters, Susan Jane Morse, Jo Ann Morse

Married Jeanne Weir Mundorff Morse, San Francisco, Calif.,
on July 27, 1947

WASTE DISPOSAL CONSIDERATIONS IN THE NUCLEAR POWERED MERCHANT SHIP PROGRAM

BACKGROUND. The basic design and operating philosophy in planning the first nuclear powered merchant ship has been predicated on complete retention of all liquid and solid wastes associated with the reactor plant, and carefully controlled venting of the reactor compartment gases.

Until actual operating experience is obtained from the first ship, containment of wastes will provide a baseline for the development and design of practicable waste disposal procedures for future ships. The collection and storage of all reactor plant wastes on shipboard, however, imposes an additional penalty in terms of cost and in weight and volume at the expense of potential cargo capacity.

N.S. SAVANNAH - REACTOR SYSTEM. The first ship in this program, the N.S. SAVANNAH, will be powered by a 74 megawatt (design) pressurized water reactor with an initial core loading of approximately 7,000 kilograms of uranium at an average enrichment of 4.4 per cent. The entire reactor system in contact with the primary coolant will be fabricated of/or clad with type 304 stainless steel.

Briefly stated, the system is designed as follows: light water primary coolant flows through the 32 element core (52,200 megawatt-day, design life) in a "triple pass" flow at average operating conditions of 508° Fahrenheit, 1,750 psia; split flow to duplicate U-tube steam generators transferring heat to the secondary side, returning to the reactor inlet nozzles via four canned rotor primary pumps downstream from the boilers. A by-pass purification system, designed to operate at a flow of 20 gallons per minute, consists of three, mixed bed ion exchangers, each with a 50 day design life, installed in parallel and to be used in sequence. Return to the primary system will be through the buffer seal system.

Major components of the primary, secondary and auxiliary systems are equipped with appropriate flow control devices, and with relief valves designed tc relieve to the waste collection system. Additional details of the reactor design are given in technical reports by The Babcock and Wilcox Company, (References 1, 2, 3).

As a matter of interest the SAVANNAH will be launched later this year, is scheduled to receive the first core in early 1960 and is expected to become operational later that year.

Since the SAVANNAH is the first nuclear powered merchant ship, the following discussion of plant operation and waste procedures is necessarily restricted to design considerations for this vessel.

SOURCE AND CHARACTER OF WASTES. From this brief description of the plant, it may be seen that operating wastes will be in the three physical forms, solid, gaseous, and liquid. Each type generally originating in specific parts of the system and requiring essentially separate types of collection and handling procedures.

Liquid Wastes. Liquid wastes on the SAVANNAH may be considered in three basic categories. The first is derived from thermal expansion and drainage during start-up procedures, secondly, operational leakage, and the third group, composed of miscellaneous wastes from sampling, laboratory, and decontamination facilities. These are further detailed in Reference 2.

Displacement by thermal expansion of primary coolant as it is heated from 110° Fahrenheit to normal reactor operating temperature (508° Fahrenheit) is on the order of 290 cubic feet (2,170 gallons). This represents the total expansion from all components in the primary system. After complete filling of the system, the pressurizer, buffer seal surge tank, and effluent condensing tank will be partially drained to their normal operating levels - accounting for an additional 147 cubic feet (1,072 gallons) of primary coolant transfer to the liquid waste collection system. These volumes in turn may be re-introduced into the primary system during thermal contraction when the reactor is being shutdown. Drainage from the condensing tank, however, will be held in the laboratory waste tank.

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Although operating wastes are difficult to predict solely from design figures, assumptions have been made in estimating quantities of operational wastes. Based on 100 days operation, these liquid wastes are expected to total approximately 490 cubic feet (3,670 gallons). This includes an estimate of 5 gallons per day from the laboratory.

Liquid waste is accommodated by a series of storage tanks totalling 1,320 cubic feet, as follows: laboratory waste tank, (67 cubic feet), two upper waste storage tanks, (260 cubic feet each), two inner-bottom tanks, (350 cubic feet each), and a 33.5 cubic foot containment drain tank which serves as an accumulator for leakage within the containment vessel. This latter tank will be drained to the larger waste tanks periodically.

Until further analysis of the waste characteristics is obtained, detailed estimates of the total quantities of radioactive materials in the waste system will not be available. However, in-pile tests of SAVANNAH fuel elements and structural materials should provide the basis for reliable prediction of these values before the ship becomes operational.

Appropriate piping and pumps will be provided for cycling wastes between tanks in the waste collection system and also for pumping these wastes to dockside transfer facilities. At this stage, liquid wastes will then be handled by a licensed commercial disposal service.

Solid Wastes. The prime source of solid wastes will be the ion-exchange resins in the by-pass purification system, (Reference 1). Mixed bed resins will be selected to remove mixtures of corrosion product activity at the maximum rate of formation, 10 milligrams per square decimeter per month. Each ion exchanger (17.5 cubic feet) will accumulate in 50 days, approximately 407 curies of activated corrosion products and impurities, plus, in the event of defective fuel elements, approximately 4.5 curies of fission products per 1,530 grams (1 pin equivalent) of fuel exposed, (Reference 2, 3). Predominant elements in the corrosion product and impurities group may include; manganese^{56}, iron^{59}, iron^{55}, cobalt^{60}, potassium^{38}, sodium^{24}, and chromium^{51}. Based on this analysis, chromium, tantalum, iron, and cobalt, are expected to account for approximately 75 per cent of the non-fission product activity accumulated on the ion-exchange resins.

As currently planned, on the SAVANNAH these nuclear grade resins will not initially be regenerated on shipboard, a standard practice with boiler feed equipment in conventional power plants. Shipboard regeneration, however, could lead to significant operating economies in the design of future nuclear propulsion systems.

Present plans call for the periodic removal of complete units containing expended resins. These units will be hoisted, in a

temporary shielding sleeve, through a vertical access trunk at the forward end of the reactor compartment and removed from the ship for temporary storage and removal. Disposal will be by shielded transport to a land based radioactive waste facility for appropriate processing or packaging for burial at the most convenient designated land or ocean disposal site (in accordance with regulations in effect at the time) by commercial organizations equipped and licensed to provide these services.

Other solid wastes may include small tools, laboratory equipment, and protective clothing which may become contaminated during maintenance operations. Materials which cannot be decontaminated easily on shipboard will be appropriately stored in designated containers for subsequent removal and processing at other facilities.

Gaseous Wastes. Pressurized water reactors inherently produce some radioactivity in the airborne and gaseous phase. For convenience, and since the methods of collection and handling are generally similar, particulate airborne and gaseous activity will be considered together.

Within the primary system, there will be some generation of off-gases resulting from the radiolytic dissociation of water under

radiation. This should be minimal since an excess of hydrogen will be available through the hydrogen addition system to recombine with the oxygen as water to reduce the corrosive action of oxygen under operating conditons. In the event of a fuel rod rupture there is a probability that fission product gases will be released into the coolant stream. The amount would, of course, depend on the extent of the defect. Calculations indicate that this may amount to 0.0834 microcuries per milliliter per 1,530 grams of fuel exposed for 100 days after 300 days of operation at full power, (Reference 2).

Within the containment vessel, the constituent elements of the normal atmosphere are also subject to direct activation by reactions of oxygen, nitrogen, and argon. The most significant concentration is due to $argon^{41}$ and has been calculated to reach a maximum concentration of 4×10^{-7} microcuries per milliliter, (Reference 2). (The maximum permissible concentration recommended by the National Committee on Radiation Protection is 5×10^{-7} microcuries per milliliter, Reference 6.)

A third source of gaseous activity is the (liquid) waste collection and storage system. To prevent compression in the liquid storage tank voids while accommodating thermal expansion of the primary system during start-up, the displaced gas must be vented.

Within the philosophy of total containment, this system has been designed so that the relief venting from these tanks will be returned to the containment vessel. Since this will occur during reactor start-up, it is expected that activity levels will be relatively low due to radioactive decay during the preceding shut-down period.

Fission gases are removed from the primary system by means of strippers, adsorption cartridges, and mechanical filters. All waste gas will be mechanically filtered before high velocity discharge to the atmosphere at the top of the forward radio mast.

The containment vessel atmosphere will normally be purged periodically at sea prior to entering a port. Containment purging is not necessary for routine operation of the ship, but will be required prior to opening the containment shell for access to the primary system for periodic inspection and maintenance.

The saturation activity of argon in the containment vessel during operation has been calculated to be approximately 400 microcuries, (4×10^{-7} microcuries per milliliter). Since this concentration of induced activity is less than the maximum permissible concentration, the only potential sources of activity in the containment air above tolerance levels would be fission products contained in leakage and relief gases from the contained systems.

With all systems functioning normally there should be no accumulation of fission products in the containment vessel air. However, prior to purging, air samples will be analyzed to determine the activity levels. If levels are above tolerable limits, purging will be carried out in such manner that there will be no hazard to passengers or the general environment.

Refueling. At the time of core removal and reloading, special facilities, either shoreside or barge-mounted will be employed to collect and retain all wastes resulting from the refueling process. Spent fuel elements will be shipped in shielded casks in accordance with accepted practice to a reprocessing plant.

Liquids and solids will be retained at the facility for decay prior to removal and ultimate disposal by a licensed contractor. Due to the variable nature of the type and extent of maintenance to be performed on the reactor system at the time of each refueling, detailed estimates of waste characteristics can not be calculated. However, for example, if the reactor were drained down to the outlet nozzles, this would amount to 388 cubic feet (2,910 gallons) of primary coolant, and if drained to the level of the inlet nozzles near the bottom of the pressure vessel, approximately 534 cubic feet (4,110 gallons). Refueling facilities will be designed to incorporate sufficient storage capacity for the entire primary system.

FUTURE PRACTICE. The preceding description of radioactive waste characteristics is necessarily limited to the SAVANNAH. With the advent of other types of reactors in the marine field, such as the boiling water, gas-cooled and other systems, the character of operational wastes may change substantially.

It is considered desirable that future commercial nuclear ship design, where feasible, be predicated on the basis of controlled disposal of some radioactive wastes directly to the open ocean. There may, however, be restrictions on the amount of waste containing very low concentrations of radionuclides which could be discharged in port areas or other congested waters. This entire problem is under active consideration by oceanographers and related specialists in an analysis of the cumulative effects of radioactive materials in the oceans including, in addition to nuclear ship operation, the current disposal of packaged and unpackaged wastes and the effects of weapons tests all in relation to the radioactive elements naturally present in sea water, (Reference 6).

The National Academy of Science has established a working panel under the Subcommittee on the Effects of Atomic Radiation on Oceanography and Fisheries, jointly sponsored by the Committee on the Biological Effects of Atomic Radiation and the Committee on Oceanography, to review the present and future operation of nuclear

powered vessels. It is expected that preliminary findings and specific recommendations of this organization will be forthcoming later this year. The International Atomic Energy Agency in Vienna and international conferences on pollution control are also examining this question.

SUMMARY. Present philosophy for the first nuclear powered merchant ship is based on complete containment of all liquid and solid wastes. Some gaseous wastes will be discharged from time to time after treatment, but only under carefully controlled conditions. The SAVANNAH embodies this principle in its design and in its operational planning.

This philosophy is believed to be prudent at this stage of development, although hopefully on the very conservative side. In order to reduce capital and operating costs for future nuclear powered merchant ships, studies are being undertaken to explore safe and feasible modifications of shipboard waste handling procedures. These may lead to the development of equipment and methods which would permit more economical operation of these ships, with respect to reactor wastes, without impairing the environment.

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3. BAW-1110, The Effects of Fission Product Leakage on the NMSR Plant, May 1958

4. WKNL-98, Nuclear Studies for the Nuclear Powered Merchant Ship, August 2, 1957

5. NBS Handbook No. 52, Maximum Permissible Amounts of Radioisotopes in the Human Body and Maximum Permissible Concentrations in Air and Water, March 20, 1952

6. NBS Handbook No. 58, Radioactive Waste Disposal in the Ocean, August 25, 1954

ROLE OF THE OHIO RIVER VALLEY WATER SANITATION COMMISSION

by

Edward J. Cleary

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Biographic Sketch

Edward J. Cleary is executive director and chief engineer of the Ohio River Valley Water Sanitation Commission. He was appointed to this post shortly after establishment of the Commission on June 30, 1948.

Mr. Cleary has practiced both civil and sanitary engineering since his graduation from Rutgers University in 1929, where he earned three degrees -- bachelor of science, master of science and civil engineer. In 1935 he joined the staff of Engineering News-Record (McGraw-Hill Publishing Co.). For the next thirteen years he travelled widely throughout the United States and Latin America to study and report on water-resources development.

He was a member of the engineering faculty of New York University during 1937-41 and is now on the faculty of the School of Medicine of the University of Cincinnati as a lecturer in water sanitation.

Mr. Cleary is a diplomate of the American Academy of Sanitary Engineering and a registered professional engineer in Ohio, New York and New Jersey.

BACKGROUND

The Ohio River Valley Water Sanitation Commission is an interstate agency (referred to hereafter as ORSANCO) representing Illinois, Indiana, Kentucky, New York, Ohio, Pennsylvania, Virginia and West Virginia. Each of these states is pledged by a compact, approved by the Congress of the United States, faithfully to cooperate in the control of pollution in the waters of the Ohio River Valley.

The compact was signed on June 30, 1948 by the governors of the eight states. Authority to enter into the compact was initially granted by Act of the 74th Congress of the United States (Public Resolution No. 104) approved June 8, 1936. Subsequent approval thereof was expressly granted by the 76th Congress (Public Resolution No. 739) on July 11, 1940.

Provisions of the compact are executed by a commission consisting of three representatives from each State appointed by the Governor of the State. There are also three federal commissioners appointed by the President of the United States.

Guided by the fundamental principle of the compact "that pollution by sewage or industrial wastes originating within a signatory state shall not injuriously affect the various uses of interstate waters", the commissioners conduct investigations, hold hearings and make determinations regarding control measures. Securing compliance with these measures then

becomes an obligation of the signatory states. To supplement state efforts in securing compliance from communities and industries, the Commission is clothed with residual enforcement powers.

Status of interstate control program

After ten years of dedicated effort by the eight states in coordinating their regional pollution-control program, substantial progress can be recorded. In the words of Dr. Russell E. Teague, present chairman of the Commission and state health commissioner of Kentucky, in his presentation of the Tenth Annual Report to the governors:

"When our regional crusade for clean streams was inaugurated in 1948 less than 4 people out of ten in the Ohio Valley were served by sewage purification facilities. Today the ratio is approaching 8 out of ten. And three-quarters of the industrial plants are now operating facilities to curb pollution; the number of industries now rated as having adequate controls is double that of five years ago. This is but one manifestation of the effectiveness of our interstate pollution-control program", concluded Dr. Teague.

RADIOACTIVE WASTE CONTROL

The states signatory to the Ohio River Valley Water Sanitation Compact have long been concerned over the possible contamination of water as a result of activities associated with development of atomic energy. In the ORSANCO First Annual Report in 1949 this statement appeared: "Operations of the Atomic Energy Commission in certain parts of the (Ohio Valley drainage) basin have posed questions relating to the disposal of wastes and their possible toxicity. These are currently under discussion".

The discussion centered then on the pending construction of the Paducah (Ky.) and Portsmouth (Ohio) diffusion plants of the AEC and on certain other installations in the Ohio Valley. At subsequent meetings with the sanitary-engineering staff of the AEC, the commissioners of ORSANCO were given verbal and written assurance that all possible safeguards were being employed. The ORSANCO commissioners took satisfaction in receiving these assurances because at that time (1949 to 1955) the industry was managed entirely by the federal government through the Atomic Energy Commission. And it was recognized that the Congressional authority establishing the AEC

provided, among other things, that the AEC shall be solely responsible for regulations and controls so that health and safety are not endangered.

Meantime, the states represented on ORSANCO were endeavoring to determine what might best serve their interests in the control of radioactive wastes before attempting to define what could be the role of their interstate agency.

In its Seventh Annual Report to the governors in 1955, ORSANCO had this to say: "For several years the Commission (ORSANCO) has been endeavoring to determine what its role should be in the control of radioactive wastes. The question assumed greater urgency this year because construction has been started on a nuclear reactor power plant at Shippingport, Pa., on the Ohio River, which is to be operated under private auspices".

"As matters now stand, the Atomic Energy Commission of the federal government maintains jurisdiction and responsibility for radiation-control measures. National policy concerning the role of the states in this new field of public-health concern has not been delineated. Exactly what should be done by this Commission and how it might be accomplished is far from clear. The questions involve development of a pattern of administrative relationships among federal and state agencies and definition of the technical procedures to be employed for monitoring and evaluation of radiation hazards".

Activities of states and ORSANCO

One of the endeavors to secure expert aid and counsel found expression in a resolution addressed to the Surgeon-General of the U. S. Public Health Service on April 5, 1955. This resolution solicited recommendations with regard to establishment of administrative relationships among the various agencies concerned with radiation hazards. And it also invited aid in developing technical procedures for the measurement and evaluation of hazards to water supplies.

In response to this resolution the U. S. Public Health Service undertook a survey of background radiation in the Ohio River. Some 40 samples of water from 34 locations were analyzed for gross radioactivity. In commenting on the survey results, the Public Health Service stated that "water samples indicated no actual or potential hazard to the public health at this time."

Meantime, ORSANCO learned from the Atomic Energy Commission that a pre-operational radiation monitoring program was being conducted in the vicinity of the power reactor under construction on the Ohio River at Shippingport, Pennsylvania. It was further stated by AEC that site monitoring would be continued by the Duquesne Light Company after the plant went into operation.

Before the Shippingport reactor went into operation the Commonwealth of Pennsylvania drafted regulations for the disposal of radioactive wastes in the Ohio River. These regulations were reviewed at a meeting of the ORSANCO commissioners on October 1, 1957. No dissent was registered by any of the signatory states with the Pennsylvania requirements.

During these years of discussion the states signatory to the Ohio River Valley Water Sanitation Compact were crystallizing their ideas and taking action to assume responsibilities. Toward this end personnel were given specialized training in radioactivity measurements, and laboratory equipment was acquired by several of the states. In addition, steps were taken in formulating radiation-control programs, notably by New York, Pennsylvania, Illinois, Ohio and Kentucky.

The conduct of radioactivity monitoring programs was studied and by 1957 there were four states in the Ohio Valley -- Ohio, Indiana, Illinois and Kentucky -- that had established routine monitor procedures. Arrangements were made by ORSANCO to receive data from these monitor points and to consolidate with it such additional records as might be made available from the AEC or the operators of AEC facilities.

Attached with this statement, and forming part of it, is a map of all the monitor points in the Ohio River Valley that were operating in 1957. With this map there is a tabulation of the monitor locations and the agency gathering the data. ORSANCO is compiling a record of radiation levels in the Ohio River and its tributaries from these 70 monitor stations as well as from five additional stations on the Ohio River that have since been established by the U. S. Public Health Service.

Appraisal of radioactivity data

Appraisal of data compiled during the past two years reveals for the most part that the present radioactivity content in the waters of the Ohio Valley district is below levels considered to have any public-health significance.

For 91 percent of the time (namely, in 885 of 976 water samples analyzed) the total activity concentrations were less than 100 micro-micro curies

per liter. Further, for 50 percent of the time the samples had total radioactivity levels less than 30 micro-micro curies per liter.

The provisional guide of the National Bureau of Standards (Handbook 52) lists maximum permissible concentrations of gross radioactivity in water where continued exposure is experienced over periods of several months at 100 micro-micro curies per liter for beta emitters and the same for alpha emitters. These values refer to man-caused additions to natural background radioactivity.

Alpha activity made up only a small part of the total radioactivity measured. The highest alpha count observed was 56 micro-micro curies per liter; however, 99 percent of the samples showed an alpha activity of less than 20 micro-micro curies per liter.

Considerable fluctuation in activity levels at various stations has been noted. During periods of significant increases in levels of radioactivity the variation pattern is somewhat similar throughout the network of monitor stations. For example, during the summer of 1957, there was a general increase in activity at most stations. By the latter part of 1957, the radioactivity had decreased to normal levels. The two years of data indicate other periods of activity build-up, but they were smaller in magnitude and less widespread in occurrence. Activity during periods of highest build-up consisted mainly of beta radiation in the suspended components of the samples. The majority of these build-ups occurred during rising river stages.

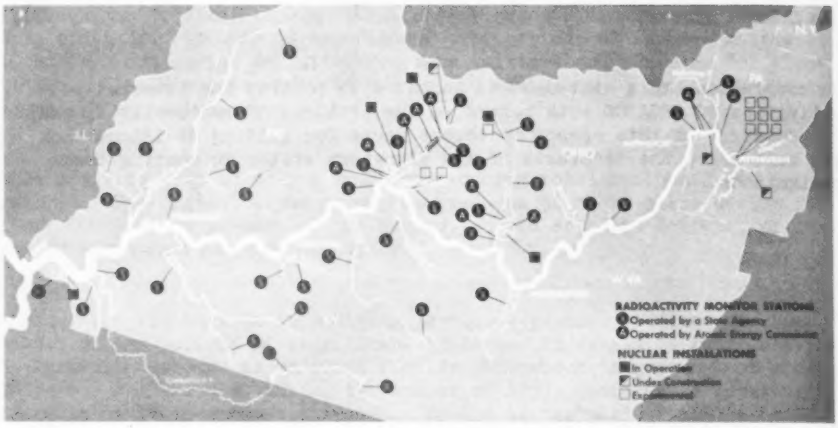
To sum up: On the basis of data compiled during the past two years it may be concluded that the radioactivity in the streams of the Ohio Valley district is well within limits defined by radiological health experts. There is considerable fluctuation from time to time in radioactivity levels, with occasional widespread increases.

ORSANCO research on river silts and biota

Consideration of the available data suggested the desirability of securing more information on the suspended radioactivity that may be carried along as part of the stream-bed silt load. Toward this end the ORSANCO commissioners have authorized a contract with the Biology Department of the University of Louisville. Started on February 26, 1958, this project is designed to provide "information regarding the accumulation of radiomaterials by various organisms of the biota, in suspended material and river sediments."

Although data thus far collected are quite sparse, the University of Louisville scientists state in an interim progress report that "significant amounts of radio-materials are being accumulated by aquatic organisms in the Ohio River. Furthermore, the patterns of accumulation apparently follow patterns for similar organisms at other localities in the United States."

In conclusion, this statement is intended to portray the interest and activities of ORSANCO with regard to the problems of radioactivity and the endeavor of this agency to secure facts for guiding decisions that may best serve the interests of its signatory states in meeting their obligations.



TRIBUTARY STATIONS	Mile Point	Operated by
Mahoning R. at Lowellville, O.	32.0	Ohio
Muskingum R. at Marietta, O.	1.0	Ohio
Hocking R. at Coolville, O.	5.4	Ohio
Big Sandy R. at Paintsville, Ky.	65.9	Ky.
Scioto R. at Lucasville, O.	15.0	Ohio
Scioto R. near Wakefield, O.	23	AEC
Scioto (Salt Creek) R. at Wakefield, O.	24	AEC
Scioto (Salt Creek) R. near Wakefield, O.	27	AEC
Scioto (Stream 1) R. near Wakefield, O.	-	AEC
Scioto (Stream 2) R. near Wakefield, O.	-	AEC
Scioto (Beaver) R. near Sargents, O.	27	AEC
Scioto (Beaver) R. near Sargents, O.	28	AEC
Scioto (Beaver) R. near Sargents, O.	29	AEC
Scioto (L. Beaver) R. near Sargents, O.	28.5	AEC
Scioto (L. Beaver) R. near Sargents, O.	28.7	AEC
Scioto (L. Beaver) R. near Sargents, O.	30.0	AEC
Scioto R. near Sargents, O.	29.0	AEC
Scioto R. at Piketon, O.	34.0	AEC
Scioto R. at Piketon, O.	34.0	Ohio
Scioto R. at Shadeville, O.	123.0	Ohio
Scioto (Darby) R. near W. Jefferson, O.	138.0	Ohio
Scioto (Darby) R. near W. Jefferson, O.	140.5	Ohio
Scioto R. at Columbus, O.	140.5	Ohio
Little Miami R. at Newtown, O.	8.5	Ohio
Licking R. at Butler, Ky.	35.0	Ky.
Miami R. at Cleves, O.	7.5	Ohio
Miami R. at Miamitown, O.	14.3	Ohio
Miami R. at Miamitown, O.	15.3	AEC
Miami R. at New Baltimore, O.	21.3	AEC
Miami (Paddy's Run) R. at Fernald, O.	23.2	AEC
Miami (Paddy's Run) R. at Fernald, O.	23.3	AEC
Miami (Paddy's Run) R. at Fernald, O.	25.3	AEC
Miami R. at Venice, O.	24.8	AEC
Miami R. at Venice, O.	24.8	Ohio
Miami R., below Franklin (5 stations)	0 - 56.5	AEC
Miami R. below Miamisburg, O. (14 stas.)	56.5 - 67.5	AEC
Miami R. at Franklin, O.	63.1	Ohio
Miami R. near Miamisburg, O.	68.0	AEC
Miami R. at Miamisburg, O.	68.7	Ohio
Miami (Mad) R. at Dayton, O.	91.6	Ohio
Miami R. at Taylorsville, O.	96.6	Ohio
Kentucky R. at Frankfort, Ky.	65.8	Ky.
Kentucky R. near Beattyville, Ky.	255.0	Ky.
Salt R. at Shepherdsville, Ky.	24.0	Ky.
Salt (Rolling) R. near Boston, Ky.	24.0	Ky.

TRIBUTARY STATIONS (Continued)	Mile Point	Operated by
Green R. near Calhoun, Ky.	63.4	Ky.
Green (Barren) R. at Bowling Green, Ky.	176.0	Ky.
Green R. at Munfordville, Ky.	213.0	Ky.
Wabash (L. Wabash) R. at Carmi, Ill.	42.7	Ill.
Wabash (L. Wabash) R. at Wayne City, Ill.	83.7	Ill.
Wabash (W. Fork, White) R. near Washington, Ind.	161.3	Ind.
Wabash (E. Fork, White) R. near Bedford, Ind.	241.3	Ind.
Wabash (Embarrass) R. at St. Marie, Ill.	178.0	Ill.
Wabash R. at Terre Haute, Ind.	215.0	Ind.
Wabash R. near Lafayette, Ind.	312.0	Ind.
Cumberland R. at Smithland, Ky.	2.8	Ky.
Cumberland R. at Burkesville, Ky.	427.0	Ky.
Cumberland R. at Cumberland Park, Ky.	565.0	Ky.
Tennessee R. near Gilbertsville, Ky.	21.6	Ky.
L. Bayou near Paducah, Ky.	3.0	AEC
B. Bayou near Paducah, Ky.	2.0	AEC
B. Bayou near Paducah, Ky.	5.0	AEC

OHIO RIVER STATIONS		
Phillips, Pa.	15.2	AEC
Montgomery Dam, near Industry, Pa.	31.7	AEC
Midland, Pa.	35.9	AEC
Dam 7, Midland, Pa.	36.5	AEC
E. Liverpool, O.	42.4	Ohio
Aurora, Ind.	496.7	Ind.
Evansville, Ind.	792.5	Ind.
Paducah, Ky.	943.2	AEC

NUCLEAR INSTALLATIONS

Research Reactors
- W. Jefferson, O.
- Waltz Mill, Pa.
- Dayton, O.

Experimental
- Pittsburgh, Pa. (B)
- Evendale, O. (Z)
- W. Jefferson, O.

Power Reactor
- Shippingport, Pa.

Nuclear Facilities
- Fernald, O.
- Miamisburg, O.
- Portsmouth, O.
- Paducah, Ky.

AEC = Atomic Energy Commission
Ill. = State Water Survey
Ky. = Water Pollution Control Comm.
Ind. = State Board of Health
Ohio = State Department of Health

STATEMENT OF
CALIFORNIA STATE DEPARTMENT OF PUBLIC HEALTH
By

MALCOLM H. MERRILL, M.D.
Director, California State Dept. of Public Health

The California State Department of Public Health has had a continuing interest in radioactivity and radiological health for many years as part of its general responsibility for the protection of the public health and its specific responsibility to prevent contamination of air, water, and food. In 1955 it was given direct authorization by legislative action to be responsible specifically for the safe disposal of radioactive wastes. The enactment authorized the Department to prohibit, by written order, the disposal of radioactive wastes by any person when, upon investigation, it has determined that the disposal is in such a manner as to endanger the lives or health of human beings. The Department is not authorized however to require submission of waste disposal plans for approval nor to adopt regulations pertaining to radioactive waste disposal.

Operating under the present limited powers the Department has initiated a preventive program in the field of radioactive waste disposal in cooperation with all agencies, State or Federal, having interest and jurisdiction in this field. Particularly, the Department has had most helpful advice and cooperation from the San Francisco Regional Office of the Atomic Energy Commission. Firms licensed by A.E.C. to dispose of radioactive wastes have voluntarily submitted their plans for approval and welcomed our inspection and advice. On May 13, 1958 our Department arranged a meeting between State agencies interested in sea disposal of radioactive wastes and private companies engaged in radioactive waste disposal. This meeting resulted in a written voluntary agreement, morally obligating the waste disposal companies to package waste material in containers of such integrity that they will remain intact at the depths prescribed and to dispose of all wastes in designated

disposal areas in conformance with pertinent legislative acts and resolutions. A copy of the voluntary agreement is enclosed.

Our Department has worked with industries constructing and operating nuclear power reactors in the establishment by such industries of programs of monitoring of effluents and the immediate surrounding environment for loss of radioactive material. We have also carried out a minimal program of inspection of such industries in cooperation with the Inspection Division of the Atomic Energy Commission.

The Department has recently developed, in cooperation with other State agencies, a plan for an environmental radiological surveillance program, a part of which pertains to waste disposal. A copy of the proposed surveillance program is also enclosed. Minimal activities along the lines outlined in this proposal are currently being carried out. Furthermore, the Department, following meetings with those industries, military installations and local public agencies which are making routine environmental radiological measurements, has accepted the responsibility of collecting, compiling and distributing quarterly summaries of all the data collected by the cooperating parties. This collection of background data is most useful in evaluating the present radiological wastes advertently or inadvertently discharged by industry to the atmosphere, to the land, or to waters fresh or saline.

In summary, we would say that we are able to follow the current trend of radiological waste disposal in this State at this early stage of development and to achieve a fair measure of prevention by voluntary means. Stronger laws, a greatly expanded technical staff, and a high degree of specialized training of technical staff, however, will be mandatory at a very early date. Before this can be accomplished it will be necessary for Congress to clarify the relative responsibilities and authorities of the States and the Federal Government with respect to regulating the civilian uses of radioactive materials.

VOLUNTARY AGREEMENT ON RADIOACTIVE WASTE DISPOSAL AT SEA OFF THE COAST OF CALIFORNIA

Pursuant to conference on the 13th day of May, 1958, held at Berkeley, California between Official Agencies in California and firms licensed by A.E.C. to dispose of radioactive wastes at sea with respect to the disposal of radioactive wastes at sea off the coast of the State of California, it is hereby mutually and voluntarily agreed that the following method and areas of disposal will be used and are considered under the present state of knowledge to be a safe means of disposal which will adequately protect human and marine life.

Wastes will be packaged in containers of such integrity that they will remain intact at the depths prescribed.

All such wastes will be disposed of in at least 2,000 fathoms of water and in a circular area of 5 mile radius centered at the following points: (A) 39° 30' N. Lat. by 125° 40' W. Longit.;

(B) 37° 40' N. Lat. by 124° 50' W. Longit.;

(C) 36° N. Lat. by 124° W. Longit.;

(D) 34° 30' N. Lat. by 122° 50' W. Longit.;

(E) 32° N. Lat. by 121° 30' W. Longit.

This voluntary agreement is made with the mutual understanding that additional information and knowledge on the subject will become available from time to time and that future meetings will be held for the purpose of re-evaluating this agreement. It is understood that this agreement has no legal binding effect on either party.

PROPOSED PROGRAM OF SURVEILLANCE OF THE ENVIRONMENT WITH RESPECT TO RADIATION

State of California
Department of Public Health

I. Introduction to Radiological Health

Man has always been subject to the effects of ionizing radiation, which comes both from naturally occurring radioactive material in the earth, and from cosmic rays which penetrate the atmosphere. It is evident that a continuous low-level exposure to ionizing radiation is always experienced and is tolerated by man and that he is helpless to prevent the exposure. Data gathered as the result of the early use of ionizing radiation, radiation accidents, and atomic weapons testing indicate known high-level exposures cause demonstrable harm. Somewhere between these limits is a level of continuous exposure, which in the light of present day knowledge appears to be relatively safe for the individual. It should be kept in mind that there is no actual tolerance level of radiation as there is for some toxic chemicals, and even the introduction of a safety factor in the allowable exposure rate cannot assure a dosage which will not be harmful.

The recent advances in technology with the development of radioactive isotopes, the increasing use of x-ray machines and fluoroscopy both in medical practice and in industry, the increasing activity in the development of nuclear energy, and the radioactive residuals incident to atomic weapons testing have significantly increased man's exposure to ionizing radiation. An additional factor, above and beyond the possible harmful effects to the individual, has more recently been established. There is general agreement that any ionizing radiation, however small the amount, reaching the reproductive cells may cause undesirable mutant changes in the genetic material transmitted from generation to generation.

There is uniform agreement that the least possible exposure to ionizing radiation is best for the individual, except where such exposure is clinical

indicated and expertly used in the diagnosis and treatment of disease. The major objective of a radiological program should be to prevent, reduce, and, when possible, eliminate unnecessary radiation exposure. This program should establish the following major functions:

1. Determine the nature and extent of the radiation problem.
2. Minimize exposure by supervision of sources and uses of ionizing radiation.
3. Perform the necessary research to develop better methods of evaluation and control.
4. Provide advice and consultation to agencies, communities and individuals.

Operational activities under each of the above headings include one or more of the following:

1. Locate, measure, and record all detectable sources of ionizing radiation, and evaluate their effects on the population.
2. Train personnel in detection, etc.
3. Keep informed on new developments in the application of radiation.
4. Determine legislative and regulatory needs.
5. Gain the support of professional societies and civic groups.
6. Encourage self-discipline among personnel authorized to use ionizing radiation.
7. Evaluate techniques and results in the control program.

A radiological health program must be initiated with a full explanation to the public and an orderly development of controls in order to prevent that kind of emotional impact which could hinder the atomic energy industry and also interfere with the medical care of our population. A radiological health program must necessarily include a program of continuous surveillance

of the environment, primarily designed to detect, measure, and record the radiation to which our population is exposed. This surveillance will provide a basis for concerted action in long-range preventive programs and for action in radiation emergencies. A program of continuous surveillance is an early and basic requirement which is essential to the orderly development of other aspects of a Radiological Health Program, such as research, evaluation, legislative controls, etc. Some of the concepts of a basic program of surveillance of the environment are presented in the paragraphs which follow.

II. Environmental Radiation Surveillance Program

A. Objective of the Program

1. To detect, measure, record, and evaluate the total radiation exposure to the population of this state.
2. To enable official agencies to take necessary action to protect the population during periods of increased intensity of radiation incident to industrial accidents, radioactive fallout, etc.
3. To provide advice and consultation to agencies, communities and individuals, concerning radiological health problems.
4. To furnish to official agencies certain information for the development of long-range programs to minimize radiation exposure of the population.
5. To continually provide the public with factual information and authoritative interpretation of data concerning radiological health.

B. Agencies Involved in Program

The surveillance program will be state-wide, will be a cooperative program of collecting, evaluating, and distributing information, with

the information and evaluations being made available to all interested agencies. The agencies will include Federal agencies, City and County Health Departments; and such state agencies as the State Department of Water Resources, Agriculture, Fish and Game, Public Health, Industrial Relations, the Water Pollution Control Boards, the Radiological Division of the State Disaster Office, and others.

C. Interpretation of Radiation Levels

1. Radiation hazards to the population can be either somatic or genetic. Somatic hazard implies a hazard to the physical well-being of the individual exposed to radiation, consisting principally of damaging "internal radiation" secondary to the deposition of radio-active substances in human tissues, such as the deposition of Sr^{90} in bones. Genetic hazard implies a hazard to future generations due to the radiation damage to the reproductive cells, consisting of an increased incidence of harmful mutations in future generations. Generally speaking, genetic hazard arises from "external radiation" in the form of natural background radiation, exposure to industrial or medical x-ray, etc.

2. The time-intensity relationship is important. There has been established by competent agencies a concept of a maximum permissible dose of (MPD) ionizing radiation. This is expressed as a certain dose of radiation in a specified period of time, such as 0.01 roentgen-equivalentman (rem) per week or equally as 0.52 rem per year. Generally, for small amounts of radiation in this range, it is immaterial whether the total dose of 0.52 rem is received on one single day during the year, or whether it is received in the form of $\frac{0.52}{365}$ rem doses each day of the year. It is not feasible to

anticipate that radiation exposures involving either somatic or genetic hazards can be kept continuously below the safe life-time rate of intensity. Radiation exposures inevitably come in short bursts of relatively higher intensity superimposed upon a continuous relatively low uniform background level. Consequently, it is necessary to evaluate exposures in terms of dose over a given period of time. Since most of the environmental media relating to radioactivity, such as rain, snow, growing crops, water run-off, are seasonal, a year is a convenient unit of time to use. The problem then consists of measuring and evaluating the total dose of radiation, both somatic and genetic, to which each important population segment in California is exposed on an annual basis.

3. The concept of "critical organ" arises from the fact that exposure to radiation is seldom uniform throughout the body, and that different organs of the body vary widely in their vulnerability to damage from radiation. It therefore is necessary to determine or estimate separately the dose to the reproductive organs, the bones, the blood, etc., in order to determine the total radiation damage.

4. The normal pattern of cycle of radioactivity in the environment must be considered in any surveillance program. Radioactivity due to the presence of radioactive chemical substances tends to cycle through the environment rather than remain static. This is best visualized by starting the cycle with radioactivity in air (fall-out) which is rapidly transferred (through rain) to soil, streams, and ocean. It then proceeds up the food chains on land and sea through plants and animals to man. Certain of these cycles are diagrammed in Figure 1. The dark shaded arrows identify the final links from the environment to man, and consequently represent the major public health concern. The

RADIATION
CYCLE IN THE ENVIRONMENT

(Internal Emitters)

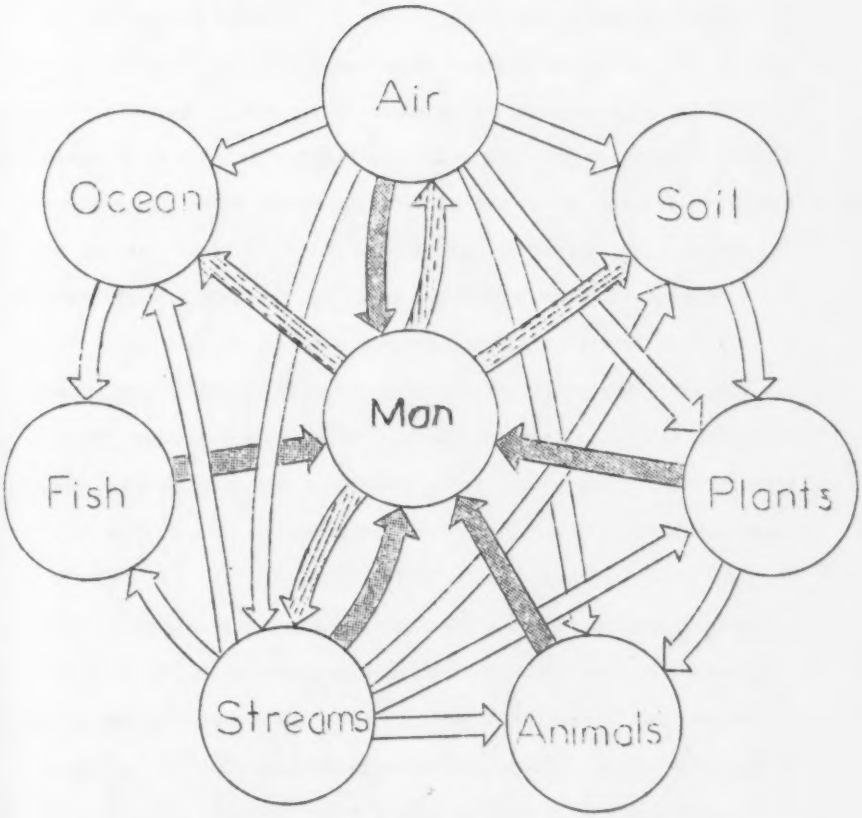


Figure 1

light shaded arrows represent the disposition of human wastes back to the environment and thus demonstrate a second opportunity for preventive control.

5. Frequently, as in the case of fallout, man's exposure to radiation is not to a single isotope but to a mixture of isotopes of widely varying half life. While this presents no obstacle to the measurement of the instantaneous rate of exposure, it prevents the prediction of the dose over a measured time. Consequently, when the instantaneous rate of exposure exceeds the safe long-time rate of exposure of the most hazardous isotope likely to be present, it is necessary to determine the amount of each significant component of the mixture and make the evaluation of hazard by considering the action of each and combining those dosages which apply to the same part of the body, i.e., the dosages to the bone, the blood, the gonads, etc. Obviously the further one goes in this specific type of identification the more time consuming the laboratory work. Consequently, the most expeditious procedure is to start with gross measurements and proceed to specific measurements only when the gross figures indicate a possible danger.

The attached chart (Table 1) indicates in three columns the criteria of evaluation of environmental media with respect to one isotope: Strontium 90, with the gross criteria in the left-hand column and the increasingly specific criteria proceeding progressively to the right. The same principle must be applied to each radioactive isotope of concern likely to be present.

STATE DEPARTMENT OF PUBLIC HEALTH

April 10, 1958

PERMISSIBLE LEVELS OF RADIATION

MEDIUM	SAFE CONTINUOUS EXPOSURE LEVEL		
	TOTAL RADIOACTIVITY (Unidentified)	BASED ON Sr^{90} + Y^{90}	BASED ON S.U. (As suggested by California Department of Public Health)
Air	1×10^{-9} μc/ml	2×10^{-11} μc/ml	
Water	1×10^{-7} μc/ml	8×10^{-8} μc/ml	
Food	1×10^{-7} μc/gm	8×10^{-8} μc/gm	$\frac{10^{-4}\ \mu c\ Sr^{90}/gm\ Ca^{*}}{\text{Discrimination value}}$
(Vegetables)	"	"	2×10^{-7} μc Sr^{90}/gm**
(Milk)	"	"	2×10^{-7} μc Sr^{90}/gm***
Soil			10^{-3} μc Sr^{90}/gm Ca****

* Permissible body burden of Sr^{90} = 100 S.U. = 100 μμc Sr^{90}/gm Ca = 10^{-4} μc Sr^{90}/gm Ca

** Discrimination value from plant to man is 1/4. Amount Ca in Vegetables is .05%

*** Discrimination value from milk to man is 1/2. Amount Ca in Milk is 0.1%

**** Discrimination value from soil to man is 1/10. (Actual range 1/4 to 1/20).

Note: Above values are based upon AEC regulations and testimony presented at hearings of the Congressional Joint Committee on Atomic Energy May 27-29 and June 3-7, 1957, on Handbook 52, NBS, and on Federal Register, Vol. 22 No. 19, dated Jan. 29, 1957.

Table 1

III. Surveillance of Air, Rain and Ambient Radiation

A. Monitoring of Air and Rain

The routine monitoring of air and rain furnishes early information of the occurrence of a significant amount of radiological fallout, particularly that resulting from the testing of atomic weapons.

The combined data on radioactive levels in air and rain (or snow) permit the making of working estimates of the total amount of activity reaching the soil in areas of food production, as well as in areas of habitation. Although decided fluctuations may occur over short geographic distances as a result of rainfall patterns, usable approximations of total fallout may be achieved by monitoring on a regional basis; that is, for major metropolitan areas, and for extensive agricultural regions such as the Sacramento or San Joaquin valleys.

The purpose of monitoring air and rain is partly to estimate the health effects of direct exposure of the population through inhalation, but particularly to indicate the need for immediate sampling of field crops and water supplies, as well as the measurement of ambient radiation.

It is desirable to locate the sampling stations for the monitoring of air and rain so as to produce data representative individually of the major metropolitan areas and the major food production areas; consequently, monitoring stations will be located in each of the three major metropolitan areas and in each of the major agricultural areas. This will require monitoring stations in Los Angeles, San Francisco Bay area, San Diego, Eureka, Sacramento, Fresno, Bakersfield, Salinas and El Centro.

Air samples will be collected daily or composite samples collected over a period of a few days. Daily catchments of rainfall will be made

at each station whenever precipitation occurs. Augmenting the normal sampling program, supplementary collections of rainfall will be made at convenient points throughout the State when this need is indicated by the levels of radioactivity found at the regular stations or by the occurrence of unusually heavy precipitation. Open containers will also be used at each station to collect the total fallout reaching the surface of the earth.

The standard method for collection of air samples will be the high volume filter sampler now used for the collection of particulate material in connection with the statewide air pollution control program. Rain will be collected in standard rain gauges, or in clean, open containers, properly calibrated, and placed so as to collect a representative sample over a 24-hour period without undue influence from buildings or other nearby structures. Surface drainage or runoff from impervious surfaces will not be used for the measurement of radioactivity in rainfall, since such surfaces will have been previously contaminated by dry fallout.

Gross beta and gamma activities will be measured on all samples. When this activity exceeds values usually experienced or when the activity is considered to be high, additional analysis will be made to identify the nature of the radioactive material. These analyses may include an estimation of the age of fission products, alpha activity and identification of specific isotopes.

Table 2 contains an estimate of the proposed measurement program for air and rain.

Table 2

Proposed Measurement Program

Medium	Locations	Samples per Month(1)	Laboratory Analyses	
			Total Radiation	Specific Analyses (3)
Air				
Daily	LA-SF-SD	90	90	6
2 per week	Sacto-Fresno-Bksf-Salinas-Imperial V., Eureka	50	50	6
Rain				
Each rainfall	(As above)	75(2)	75	20

(1) Samples during any one month. These numbers will vary according to season and occurrence of fallout incidents.

(2) During winter.

(3) Estimated number of samples that might require specific analyses.

B. Monitoring Ambient Radiation

Measurements of ambient radiation are for the purpose of determining the exposure of inhabitants of an area to external beta and gamma radiation. Measurements are made three feet above ground surface, with equipment sensitive to at least .01 milliroentgen per hour.

Normal levels of ambient radiation in California during the past two years approximate from .01 to .02 milliroentgen per hour. An increase to .05 milliroentgen per hour would be considered a threshold of public health

concern, if it were to persist for more than a short period of time.

C. Point Source Program

A considerable number of industries and research agencies have in their possession quantities of radioactive material which could become hazardous to the public if dispersed in the air environment. In addition, there is a growing number of licensed power reactors having a capability of potential emission of large quantities of radioactive material to the environment in case of faulty operation or accident. It is customary in such cases, particularly power reactors, for the industry or agency in charge to carry out environmental monitoring routinely, in the vicinity of its operation. Such monitoring usually consists of continuous measurement of liquid or gaseous effluents, and the periodic collection and radiological assay of samples of air, soil, vegetation, etc., in the vicinity.

It is not proposed that the State duplicate such activities, except for the collection of occasional samples to verify the results of measurements of the operating agency. Instead, arrangements will be made for regular receipt by the State of results of measurements made by isotope users and operators of power reactors.

In the future it may be necessary for the State to stipulate by regulation the scope and nature of monitoring to be carried out by such industries and users of radioactive material.

D. Evaluation of Measurement Data

In evaluating results of measurement of radioactivity in air and rain, interpretation will be based upon the recommended permissible levels of radioactivity in air, water and food of the National Committee on Radiation Protection and Measurement. The recommended permissible level for continuous inhalation of unidentified fission products is 1×10^{-9} uc/ml of air.

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In the past fallout episodes in California the highest levels measured have been approximately 1/20th of this value. The dose to humans is determined by the duration of exposure as well as the level of activity. Since occasional high levels of activity can be experienced for short periods without a marked increase in dose there is a need for establishing levels of radioactivity in air which can be used as guides in calling for some type of action to protect the public health. The following table indicates the kinds of levels that might be used, where X is a value yet to be selected.

(a) Monthly
average exceeding (x) times the recommended permissible levels for continuous inhalation.

(b) Weekly
average exceeding (10x) the " " " " " inhalation

(c) Daily
average exceeding (35x) the " " " " " "

Levels of radioactivity in rainfall can only be appraised from the standpoint of safety by taking into account the method by which human beings may become affected; that is, by contamination of drinking water, food, or surfaces.

At the present time, no permissible level for rain, as such, can be stated. When levels of radioactivity in rainfall exceed the standard recommended for drinking water, namely 1×10^{-7} uc/ml, it is necessary to direct attention immediately to exposed field crops and sources of drinking water supply. General guides can be developed for levels of activity in rain, where resulting radioactivity in crops and drinking water will be of immediate concern to the public health.

IV. Surveillance of Fallen Snow, Surface Waters and Domestic Water Supplies

A. Fallen Snow

The determination of radioactivity in fallen snow is subject to a number of factors which make interpretation of the monitoring results complicated. To begin with, the snow pack is composed of successive layers representing different storms. Between storms, the snow pack may diminish both by evaporation, which has the effect of removing the most recently deposited layers, and by melting, which results in the mixing of successive layers. Shrinkage of the snow pack, in addition, will entail the concentration of dirt and other impurities on the surface. The result of these factors is that radioactivity in surface samples from the snow pack does not diminish in accordance with the decay curve of radioactive components. On the contrary, in a succession of samples from the same snowbank, later samples may actually show a higher exposure level of radioactivity than the original ones.

On the other hand, in the higher altitudes, the snow pack may contain a substantial portion of the total radioactive fallout for a year.

For these reasons, it is imperative to monitor the snow pack, particularly during the months when snowfall occurs. Because of the factors affecting distribution of radioactivity within the snow pack, it is desirable that core samples for the full depth of the snow pack be collected.

The Department of Water Resources maintains a program of gauging of snow pack at approximately fifty stations under contract. It is proposed that monthly samples for radioactivity be collected at each of these stations during the winter months.

B. Surface Waters

Since 1950, semiannual measurements of radioactivity have been made of the principal fresh water streams of the State, at a network of approximately 150 stations. This activity has been carried out under contract by the Department of Water Resources for the State Water Pollution Control Board as part of a comprehensive stream sampling program. Measurements have been made by the Radiological Division of the California Disaster Office.

Inasmuch as this program commenced several years before the first testing of nuclear weapons in this country, the first results reflected natural radioactivity resulting primarily from mineral deposits in the mountains. Samples from the official Stream Sampling Stations in recent years have not shown significant increase in radioactivity resulting from fallout. Consequently, the results of this stream sampling program still represent natural background radioactivity in California waters.

The program, without question, should be continued. Unless results of sampling begin to show significant increase, it should not be necessary to increase the scope of this program.

C. Domestic Water Supplies

Most of California's domestic water supplies come from surface sources. Radioactivity in such water supplies consists of the natural radioactivity in the surface streams, plus radioactivity added by the discharge of sewage or industrial waste effluent to the streams, plus the results of fallout, particularly into open, terminal or distribution reservoirs.

Consequently, domestic water supplies must be monitored on a continuous basis, since it is impossible to forecast levels of radioactivity on the basis of radioactivity in rain, snow, or surface streams.

Furthermore, the recommended permissible level of radioactivity in water, namely, 1×10^{-7} uc/ml, applies only to drinking water itself. Several of the large metropolitan water companies have facilities for measuring gross beta and gamma activity in their own water supplies. The routine monitoring of the major water supplies in the State, exclusive of the Metropolitan Water District of Southern California, the Los Angeles City Water Department, and the East Bay Municipal Utility District water supply, requires a minimum of thirty monthly source samples throughout the year, greatly augmented at times of high radioactive rainfall; and supplementing the above through a field appraisal of potential public health hazards.

Emergency Action

1. With respect to activity resulting from fallout, the departmental action will be as follows:
   a. If activity is below 10^{-7} uc/ml, no action will be taken.
   b. If activity is between 10^{-7} and 10^{-5} uc/ml, the public may be told that the water may be used for a limited time (up to two months) without unreasonable hazard. Further check will be made for decay rate and for specific nuclides.
   c. If activity is between 10^{-5} and 10^{-3} uc/ml, the Department will immediately notify the USPHS. Further checks will then be made to see if the decay rate is typical for fresh mixed fission products in fallout, and, if so, we will follow the procedure described in (b) above.
   d. If activity is in excess of 10^{-3} uc/ml, the Department may direct that bottled water or an alternate supply of safe water, if available, be used by the public; and an immediate report will be made to the Civil Defense authorities.
2. The same general policies will be followed on non-fallout conditions.

V. Surveillance of Waste Disposal

A planned disposal of radioactive wastes is accomplished in two basic ways: by discharge to the public sewers and by burial in the ocean or on land. In addition, radioactive waste disposal problems may be alleviated by storage of waste until levels of radioactivity have decreased through normal decay.

Monitoring through the collection of environmental samples is necessary for radioactive discharge to the sewers and burial in the ocean. Sewage is most economically monitored as it reaches a treatment plant, because in this manner a single sample reflects the loading discharged to the entire sewer system.

Unusually high values encountered in such monitoring point up the need for intensive investigations to discover the sources. It is advisable to monitor not only raw sewage, but also treated sewage effluent and sewage sludge, particularly when these are re-used and may be recycled in the food chain. Monitoring of ocean waters in areas where radioactive wastes are buried is for the purpose of discovering improper practices where package wastes are dumped, since, barring mishap or faulty practice, no escape of radioactivity to the ocean waters should occur.

The proposed schedule of monitoring in ocean waters is based on the assumption that all wastes will be packaged, and no bulk solids or liquids will be discharged directly to the ocean waters.

Routine monitoring will involve a sampling schedule as shown in the following Table 3.

Table 3

Surveillance of Water and Wastes

	Samples per Month	Total Radiation	Specific Analyses
Ground Waters (1)	1	1	-
Surface Sources (2)	55	55	1
Sewage-Industrial Wastes (3)	27	27	1
Sludge (3)	15	15	10
Salt Waters (4)	2	2	2
Fallen Snow and Melt	75	75	18
Totals	175	175	32

(1) Does not include needs of Dept. Water Resources, Water Pollution Boards,etc.
(2) Includes State Stream Sampling Program but not the needs of WPC Boards, Fish and Game, Dept. Water Resources, etc.
(3) Includes only WPC Board No. 4's Hyperion Monitoring and Dept. Public Health's needs.
(4) Does not include needs of Dept. of Fish & Game, WPC Boards, etc.

In addition to collection of samples, surveillance of waste disposal operations will be accomplished by inspection and review of facilities and operations.

The principal characteristics of the proposed waste disposal surveillance program will be as follows:

A. Monitoring

1. Samples of sanitary sewage effluents and sludges will be submitted on a monthly basis by the major sewage works operators. The number may approximate 10 plants or 20 samples per month. Should any effluent sample exceed 10 x MPC, additional samples will be taken and, if still high, an attempt will be made to locate sources of radioactivity and further appraise the hazards of effluent disposal.

2. Review of waste monitoring data being collected by reactor operators, waste disposal companies and isotope users will be made periodically. Occasional check samples will be run; these may be on the order of two analyses per month.

3. Special surveys and sampling for local agencies will be carried out on request if feasible.

B. Inspection and Review of Facilities and Operations

1. Periodic inspections will be made of facilities and operators which handle or could produce appreciable quantities of radioactive wastes, except medical isotope use by individual physicians, and sealed sources. The term "appreciable quantities" is difficult to define because of the variation in hazard potential, isotope, and qualification of use. An estimated 10 samples per month will be analyzed.

2. Develop through liaison with A.E.C., industry, et al, an opportunity to participate in site selection in the absence of a State licensing or permit procedure.

3. Evaluate the public health hazards of any proposal to dispose of wastes or to use isotopes as tracers whereby such tracers are deliberately introduced into the environment and reach the waters of the State, directly or indirectly.

VI. Surveillance of Food

Surveillance of the food supply is based upon the concept of the cycling of radioactivity through the food chain in one of several ways.

Probably the principal manner is the transfer of radioactivity from the soil into growing plants, thence into animal products, and finally to man.

A second, and shorter route is the direct contamination of growing field crops by radioactive rain.

A third route is the development of low levels of radioactivity in ocean water which would be entirely insignificant to humans were it not for the fact that plankton and other marine organisms are capable of reconcentration of radioactive isotopes many thousandfold. It is believed that with respect to the food chain on land, it should be possible to establish reliable relationships between the concentration of significant isotopes (such as Strontium 90) in soil, in plants, in animals and in man, which would enable monitoring to be accomplished by measurement of radioactivity in only one of these links in the food chain.

With this in mind, it is proposed that for the first few years, all elements in the food chain be monitored so that this relationship may be established.

Monitoring of food on land has been planned on a regular basis with measurements being made in each of the following five food raising areas:

1. Sacramento Valley
2. Delta Area
3. San Joaquin Valley
4. Salinas Valley
5. Imperial Valley

In each of these locations, samples will be collected systematically of soil, representative fruit and vegetable crops, beef, milk,and bone.

With respect to the ocean food chain, systematic sampling will be carried out in two locations of the State on ocean water shellfish and skeletal fish.

In planning the frequency of sampling, account will be taken of the fact that radioactivity in soil changes very slowly and that a soil sample gives an integrated value representing several years of exposure; while a food commodity, like milk, gives an integrated value over a period of several weeks.

The proposed sampling schedule is as outlined in Table 4.

VII. Surveillance of Medical, Industrial, and Commercial Uses of Radiation

A. The medical and allied professions contribute a substantial portion of the total radiation to the population in the form of x-ray, fluoroscopy, and the use of radioactive isotopes. The general industrial safety orders of the State Division of Industrial Safety deal with the protection of employees exposed to potentially dangerous levels of radiation. These orders are occupational in character, and permit an occupational maximum permissible dose of radiation which is 10 x the maximum dose permitted to the population as a whole. These orders extend to the protection of the public only incidentally. There is now almost complete agreement that the same kind of protective action should be extended to patients and to casuals. Generally, there is no regulation elsewhere of the medical and allied professional use of radiation for

SURVEILLANCE OF FOOD

Sampling Schedule

Commodity	Sampling Schedule	Samples Per Year	
		Total radiation	Specific analysis *
Representative Leafy Vegetables	Once/crop	120	120
Representative Root Plants	Once/corp	120	120
Processed Fruits and Vegetables	5 Products	120	120
Fresh Milk	Monthly	48	48
Condensed Milk	Twice/yr.	8	8
Dried Milk	Twice/yr	8	8
Beef (domestic)	Twice/yr	12	12
Beef (imported)	Twice/yr	12	12
Animal Bone	Once/yr	12	12
Poultry	Twice/yr	12	12
Eggs	Twice/yr	12	12
Sardines	Twice/yr	12	12
Tuna	Twice/yr	12	12
Shellfish		24	80

* Specific analyses may be limited to the determination of Potassium 40, may include only Strontium 90, or more complete isotopic analysis.

Table 4

diagnostic or therapeutic purposes, except for the Federal Regulations applying to licensees of the Atomic Energy Commission in the uses of radioactive materials. Surveillance of radiation activities relating to the medical and allied professions is a proper concern not only of public health agencies, but also the professional societies and the individual prescribers and users of radiation, as all are equally obligated to guard the public against any unnecessary exposure. Controls must not limit the intentional exposure of patients to radiation for the purpose of diagnosis, therapy, or research as authorized by law. However, radiation in the above instances should be used only where clinically indicated and with proper and expert supervision and operating conditions. The benefits must continually be evaluated in terms of the hazards involved. Controls relating to these uses of radiation must be broad in scope, with provision for revision as required . The success of any control program relating to medical uses will depend almost entirely on the active support, cooperative effort, and self-discipline of the entire medical and allied professions of the State.

B. The industrial and commercial uses of radiation in California have progressed to such an extent that this State is now one of the primary areas of nuclear development. In order to encourage continued and optimum progress in the future, the State must initiate action to develop the necessary regulatory framework, standards and controls. This must be supported by an effective program of public information and education to insure effective and cooperative

effort based on a realistic appraisal not only of the potential hazards but also the great social and economic benefits of atomic energy.

C. A radiation surveillance program can be evaluated only on the basis of thorough understanding and appreciation of the many facets of radiation. The more important of these are the concept of somatic hazard to the individual as compared to the genetic hazard to the population as a whole; the concept of a natural background radiation as compared to the added radiation from man-made sources and procedures; and the obvious benefits of radiation to mankind in the form of medical uses, research and atomic energy as compared to the hazards.

D. Surveillance activities relating to medical, industrial, and commercial uses include the following:

1. Registration of sources of radiation
   (with exceptions based on nature of materials and magnitude of activity)
   a. Information concerning location, nature, magnitude, form, use.
   b. Freedom of access to further information.
   c. Notice of accident or unusual occurrence.

2. Development of standards of machines, facilities, and installations, with provision for inspection.

3. Development of standards of good operating practice, with provision for inspection.

4. Measurement and assessment of the total population exposure.

VIII. PROPOSED LABORATORY FOR RADIOLOGICAL SURVEILLANCE PROGRAM

The foundation of a sound program of evaluating radiological hazards in the environment is an adequate laboratory. It is believed that a single laboratory closely associated both with the sampling program and with the interpretation of analytical results can most efficiently and economically serve the needs of the program. The following evaluation of laboratory requirements is predicated on one such laboratory.

A. Sampling program:

Type of sample	Laboratory analyses/month	
	Gross beta-gamma measurement	Specific analyses*
Air	140	12
Rain	75	18
Snow	75	18
Water, fresh	56	1
Water, saline	2	2
Sewage and industrial wastes	27	1
Sewage sludge	15	10
Food, plants	30	30
Food, milk	6	6
Food, meat	2	2
Food, bone	1	1
Food, fish	2	2
Food, shellfish	2	4
Food, poultry and eggs	2	2
Soil	1	1
Totals	436	110

*Specific analyses may vary from relatively simple decay measurements to complex, time-consuming isotopic analyses.

B. Gross beta-gamma measurement:

Sample Type	Sample No./month	Man-hours per sample	Total man-hours per month	Instrument-hours per sample	Total instrument-hours per month
Air	140	0.3	42	0.7	98
Rain, snow, fresh water	206	0.5	97	0.7	135
Sewage	27	1.0	27	0.7	19
Sewage sludge, food, soil, salt water	63	1.3	82	0.7	44
Totals	436		248		296

C. Specific analyses:

On all samples for which specific analyses are indicated, the rate of decay shall be measured. If additional analyses, especially isotopic analyses, are required, it is impossible to predict accurately the time requirements. On the basis of past experience it seems reasonable to assume an average of 12 man-hours per sample for specific analyses exclusive of decay measurements.*

1. Decay measurements:

   The man-hours and instrument-hours are the same for all samples, respectively, 0.5 and 2.7. Thus, for 110 samples, a total of 55 man-hours and 297 instrument-hours are required.

2. Isotopic analysis:

   As indicated above, 12 man-hours per sample may be used as an average (but probably minimum) value. Thus, for 110 samples, 1,320 man-hours are required.

*Of necessity, the relative newness of the field will require some time to be devoted to methods development. An allowance for this time is included in the 12 man-hour per sample figure. An allowance for time lost due to vacations and holidays is likewise included.

D. Personnel requirements:

1. Gross counting and decay:

Three hundred and three (303) man-hours or 1.8 men. It is suggested that an electronics technician and a chemist with an electronics background be used. Since two people are suggested, there will be adequate time allowed for equipment maintenance and repair (as well as actual sample counting) by the electronics technician. The electronics technician will also service all other laboratory and field equipment.

2. Isotopic analysis:

1,320 man-hours (minimum) or 7.8 men (minimum). It is suggested that 6 public health chemists and 2 laboratory assistants be used.

3. Calibration and maintenance of field equipment:

It is suggested that one chemist, with the part-time assistance of the electronics technician, will be able to handle this.

4. Clerical:

One clerk to handle routine office procedures; one clerk to handle data produced by the laboratory.

E. Equipment requirements:

1. All gross beta-gamma measurements, including decay, on unseparated isotopes shall be made with a proportional gas flow counter. A single automatic sample changer counting assembly together with 3 manual gas flow counters will be minimal for these measurements (the down time on this equipment was taken to be 25%).

2. Measurement of separated isotopes may be made with a scintillation detector (gamma sensitive) or with a Geiger-Muller counter. Both types of counting equipment are needed. A Geiger-Muller counter will be especially valuable in making absorption studies.

3. Measurement of unknown mixtures of isotopes for which rapid evaluation is desired can be facilitated by the use of a gamma ray spectrometer. This would be especially valuable in dealing with atomic accidents. It is suggested that for the present a single channel spectrometer is needed. Future needs may, however, dictate use of a multi-channel (100 or more) spectrometer.

4. Accessory laboratory equipment must include: fume hood, large capacity balance, analytical balance (preferably single pan), large capacity muffle furnace, one or more centrifuges, oscilloscope, pulse generator, vacuum tube voltmeter, tube tester, spare tubes, tools, etc.

F. Training

An adequate training program must be established to

1. provide chemists with specific knowledge in the field of radioactivity and its measurement, and
2. provide chemists with specific knowledge of radiochemical techniques.

G. Space requirements

It is roughly estimated that adequate hood and bench space will require about 3500 sq. ft. of floor space for the personnel and equipment noted above.

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ACTIVITIES OF THE COLORADO STATE DEPARTMENT OF PUBLIC HEALTH IN REGULATING DISPOSAL OF RADIOACTIVE WASTES

By

W. N. Gahr, State Sanitary Engineer and Director
Division Sanitation for Colorado Department of Public Health

Born: June 6, 1910, near Haynes, Adams County, in southwestern North Dakota

Education: Public grade and High School, University of North Dakota - B.S. in Civil Engineering 1940.

Harvard University - M.S. in Sanitary Engineering 1947.

Work History: Worked on and in a partnership on a grain and stock farm in southwestern North Dakota. Worked out of Grand Fork's Division, Engineers Office, Great Northern Railway Company. Worked as junior engineer for North Dakota Health Department. Army Sanitary Corps Officer during World War II; separated as a major. Returned to North Dakota Health Department. State Sanitary Engineer for Colorado from 1950 to present.

Activities of the Colorado State Department of Public Health pertaining to regulating the disposal of radioactive wastes has of necessity required considerable investigation of a problem. A presumed problem, since the finding of radioactive substances,has never been too unusual in parts of the State. Consequently, not until really large scale production of areas containing uranium did any interest develop concerning radioactivity and its effect upon the environment.

However, since the development of such an interest, work was started and continues on this problem. It began with investigative work aimed at assessing the nature of the problem. This led to meetings, to the promulgation of State Board of Health regulations, and to a Surgeon General's conference on interstate pollution. It has most importantly led to a healthy cooperative interest on the part of industry, State and Federal Agencies, as to how the pollution problem can best be handled.

Historically, production of ores exhibiting radioactivity occurred during and after World War I. At this time, ores for the production of radium were processed in the Uravan area. Actually, this production was for use of the French scientists, Marie and Pierre Curie, in their experimental work. Cheaper source of such ores elsewhere ushered in a decline in ore processing for this purpose in Colorado. However, the establishment of vanadium as a useful and needed metal kept mining and milling of these ores alive. The coming of the Manhattan Project, during World War II, saw the mills redesigned to extract uranium as well from these ores. Stimulation for even greater production after World War II led to the ultimate construction and operation in Colorado of six ore processing mills having the greatest capacity yet.

The change from small and minor processing of radioactive ores to the much larger amount of processing naturally focused attention upon a need to determine if a problem of waste disposal did indeed exist. Once the need for looking into the matter was established various investigations were undertaken.

Preliminary discussions led to the collection of eight water samples by Public Health Service Sanitary Engineers from the rivers at points in the vicinity of Durango, Naturita, Uravan and Rifle. Mills processing ores for uranium

exist at all of these cities and towns. The samples were subsequently analyzed for dissolved radium content.

During August 1951, the results from the above water samples being available, a meeting was convened in Durango for the purpose of trying to develop a program aimed at continuing the studies pertaining to the pollutional effects of uranium milling wastes. This meeting pointed the need for better techniques, particularly in analytical work. Nor was dissolved radium polluting surface waters considered too important at this particular session.

During September of 1955, a Public Health Service survey team covered the same geographical area mentioned above. Water samples for radio-assay were collected and ore processing at two mills observed.

During December 1956, Colorado State Health Department held a meeting in Denver attended by several Federal representatives in addition to the Public Health Service. Purpose of this meeting was two-fold, (a) discuss effects of uranium ore milling and processing upon air and water in the environment, (b) discuss findings of samples collected in September 1955.

Meetings then became an annual occurrence, with one at Cortez during October 1957 to which were invited representatives of the States of Arizona, New Mexico, Utah, as well as those from Federal and Colorado Agencies. Again, the purpose was to assess the problem of water pollution resulting from uranium milling wastes. Following the above meeting, a conference on interstate pollution of the Animas River was held April, 1958, in Santa Fe, New Mexico, under the authority of the Surgeon General, Public Health Service. Later in October, 1958, the Atomic Energy Commission called the representatives of eight states plus many of the intrested Federal Agencies and uranium mining and milling operators to a meeting at Grand Junction. This meeting was designed to acquaint all concerned with the pollution problem caused by the uranium mill processing wastes. It proved most beneficial; especially for working toward better handling of these particular wastes.

The foregoing indicates the procedure normally followed when a new problem appears; it points the requirement for much scientific investigation before rigid controls are considered. The result of investigations into the disposal of radioactive wastes naturally led to the consideration for regulation. In this respect, the Colorado State Department of Public Health leans heavily upon Handbook No. 52 and more recently upon Part 20 - Standards for Protection Against Radiation. As early as October 1953, the State Board of Health promulgated a regulation prohibiting the discharge into waters of the State of substances in amounts toxic to man; these regulations were readopted in January 1947 and contained minor changes.

Action by the Surgeon General in the matter of interstate pollution on the Animas River, pointed the need for still further research and scientific investigation as to the magnitude of this special pollution problem.

In addition to the above mentioned sampling programs, the Colorado State Health Department has and is collecting and analyzing stream water samples at various points in the State. Not only water, but also stream biota and mud samples are collected. However, the work is rather costly and must, therefore, be limited. A network of basic water quality data stations throughout the State is appearing as an

and would be most helpful in establishing background data.

References:

1. "Domestic Sewage and Industrial Waste Effluent Standards"
Adopted Oct. 28, 1953 by Colorado State Board of Public Health

"Sewage and Trade Wastes Effluent Regulations"
Adopted January 14, 1957 by Colorado State Board of Health.

2. Transcript of Conference on Interstate Pollution of the Animas River Colorado - New Mexico - Santa Fe, New Mexico April 20, 1958.

3. Uranium Mill Wastes - William N. Gahr, Oct. 1958.

COLORADO STATE DEPARTMENT OF PUBLIC HEALTH
DIVISION OF SANITATION

January 14, 1957

SEWAGE AND TRADE WASTES EFFLUENT REGULATIONS

Under authority contained in Chapter 66-1-7 (5), Colorado Revised Statutes 1953, the following regulations are established governing the minimum quality of the effluents of sewerage systems and trade wastes discharged upon the land or into the surface or ground waters.

1. The following definitions shall apply to terms used in these regulations:

   A. Effluent of Sewerage Systems means any liquid containing toxic substances or suspended, floating, or dissolved matter discharged upon the land or into the surface or ground waters.

   B. Trade Wastes means any liquid containing toxic substances or suspended, floating, or dissolved matter originating from industrial processes as distinct from domestic or sanitary sewage and discharged upon the land or into the surface or ground waters.

   C. Matter means chemical substances of animal or vegetable origin.

   D. Discharged upon the land is not to be considered as applying to land used as part of a special disposal process for the purpose of eliminating trade wastes and effluent from sewerage systems.

2. The effluent of sewerage systems or trade wastes shall not contain substances in quantities toxic to man.

3. No floating matter shall be discharged in the effluent of sewerage systems or trade wastes.

4. The effluent of sewerage systems and trade wastes shall not contain settleable matter exceeding five tenths (0.5) milliliter per liter.

5. The effluent of sewerage systems and trade wastes shall not contain suspended matter exceeding seventy-five (75) parts per million.

6. That portion of domestic sewage or industrial waste that is dissolved or suspended in the effluent of sewerage systems or trade wastes shall not exceed fifty (50) parts per million when measured in terms of five-day, twenty degree Centigrade, Biochemical Oxygen Demand (5-day, 20°C BOD) in any case. However, if the effluent of sewerage systems or trade wastes are discharged into a watercourse used downstream in Colorado as a surface source of public domestic water supply, the dissolved or suspended matter shall not exceed thirty (30) parts per million when measured in terms of five-day twenty degree Centigrade Biochemical Oxygen Demand.

7. Methods used in determining compliance with these standards shall be in accordance with Standard Methods for the Examination of Water, Sewage, and Industrial Wastes, 10th Edition. Such determinations shall be based on the average of results during the period under study and in all cases shall consist of at least four (4) samples taken at intervals of at least one hour.

8. Regulations 1 through 7 shall apply immediately to all new construction, including that financed under Public Law 660, and to effluents of sewerage systems and trade wastes discharged upstream of sources of domestic public water supply; for other municipalities, sanitation districts and industries time for compliance with these standards is extended until January 1, 1958.

Adopted by the State Board of Health January 14, 1957.

Reference:

Chap. 66-1-7 (5) CRS 53 - Effluent Regulations and Enforcement.
Chap. 66-1-7 (19) CRS 53 Amended - 1,000 Coliform organisms per milliliter maximum allowable in effluent.
Chap. 40-12-22 CRS 53 - Polluting Streams - penalty.
Chap. 40-12-23 CRS 53 - Unlawful to flow oil into streams - penalty.

CONFERENCE AT SANTA FE, NEW MEXICO
On Interstate Pollution
Of the Animas River, Colorado-New Mexico

Chairman: Mr. Murray Stein
Chief of the Enforcement Section
Water Pollution Control Program
U. S. Public Health Service
Washington 25, D. C.

Conferees: Mr. Keith S. Krause
Assistant Regional Engineer
Public Health Service - Region VII
Dallas, Texas

Stanley J. Leland, M. D., Director
New Mexico Department of Public Health
Santa Fe, New Mexico

Mr. Charles G. Caldwell, Director
Environmental Sanitation Services
New Mexico Department of Public Health
Santa Fe, New Mexico

Roy L. Cleere, M. D., Executive Director
Colorado Department of Public Health
Denver, Colorado

Mr. William N. Gahr, Director
Division of Sanitation
Colorado Department of Public Health
Denver, Colorado

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OTHER APPEARANCES

U. S. Public Health Service:

Dr. E. C. Tsivoglou
Chief of Technical Water Pollution Research
Robert A. Taft Sanitary Engineering Center
Cincinnati, Ohio

Mr. Robert Morfitt, Sanitary Engineer
Indian Health Facilities, Public Health Service
Window Rock, Arizona

Atomic Energy Commission:

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Grand Junction, Colorado

Dr. Don I. Walker
Idaho Operations Office
Idaho Falls, Idaho

Mr. Robert F. Barker
Division of Licensing and Regulation
Atomic Energy Commission
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Vanadium Corporation of America:

Mr. John A. Maxwell
Vanadium Corporation of America
Durango, Colorado

Mr. Fred A. Brinker
Vanadium Corporation of America
Durango, Colorado

State of Colorado:

Mr. Richard L. Moore
Colorado State Game and Fish Department
Denver, Colorado

Mr. W. L. Bruce, Secretary-Treasurer
Animas River Water Users Association
Durango, Colorado

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Denver, Colorado

John B. Barnard, Jr.
Assistant Attorney General
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State of New Mexico:

Warren A. Rasmussen, M. D.
District Health Officer
San Juan County Health Department
Aztec, New Mexico

State of New Mexico: (continued)

Mr. Robert P. Lowe, Assistant Director
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Santa Fe, New Mexico

Mr. Carl R. Jensen, Assistant Director
Environmental Sanitation Services
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Santa Fe, New Mexico

Mr. Steve E. Reynolds
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Santa Fe, New Mexico

(A list of others in attendance is attached as "Appendix A")

MR. STEIN: May we get started? The Conference is open.

This conference in the matter of pollution of the interstate waters of the Animas River involving the States of Colorado and New Mexico, is being held under the provisions of the Federal Water Pollution Control Act. Under the terms of that Act the Surgeon General of the Public Health Service is required to call a conference of this type when requested to do so by a State water pollution control agency. Upon receipt of a request from Doctor Leland, State Health Officer of New Mexico, this conference has been called by the Surgeon General. The purpose of the conference is to bring together State and local water pollution control agencies and the Public Health Service, and other interested parties to review the existing situation, the progress which has been made and to lay a basis for future action by all parties concerned, and to give the States, localities and industries an opportunity to take any remedial action which may be indicated under State and local law.

The conference technique is a rather old one. As a matter of fact it is used by many State agencies informally in the normal conduct of their business in the field of water pollution control. The notion of a conference was proposed by United States Supreme Court in the famous case of New York and New Jersey involving interstate pollution. The court said as far back as 1921 "We cannot withhold the suggestion, inspired by the consideration of this case, that the grave problem of sewage disposal presented by the large and growing populations living on the shores of New York Bay is one more likely to be wisely solved by cooperative study and by conference and mutual concession on the part of representatives of the states so vitally interested in it than by proceedings in any court however constituted."

This we think is particularly applicable to the relatively complex situation such as we have in the Animas River. Under Section 8 of the Federal Act the Surgeon General has notified the official State water pollution control agencies of this conference. These agencies are the Colorado State Department of Public Health, and the New Mexico Department of Public Health. Under the law this is a conference between these official agencies and the Public Health Service. The official agencies of course are privileged to bring whomever they wish to the conference and have them participate in the conference. The conferees have been designated by these agencies: for New Mexico the conferees are Doctor Stanley Leland, Director of Public Health of that State, and Mr. Charles G. Caldwell, State Sanitary Engineer; for Colorado, Doctor Roy L. Cleere, Executive Director of that Health Department, and Mr. William N. Gahr, State Sanitary Engineer; for Public Health Service, Mr. Keith S. Krause, Assistant Regional Engineer, Region VII; and my name is Murray Stein, I am from headquarters, Public Health Service.

Both the States and Federal Government have responsibilities in dealing with interstate water pollution control problems. The Federal Water Pollution Control Act declares that the States have primary rights and responsibilities for taking action to abate and control interstate pollution. It has always been the policy of the Public Health Service to recognize this traditional role of the States. The function of the Public Health Service is to encourage the States in this activity. However, the Public Health Service is charged by law with specific responsibility in connection with interstate pollution control problems.

The Federal Water Pollution Control Act provides that pollution of interstate waters which endangers the health or welfare of persons in a State other than that in which the pollution originates is subject to abatement. The conference will be useful in providing a clear record delineating the progress which has already been accomplished and indicating what still needs to be done in correcting the interstate pollution problem. Under the Federal Law the Surgeon General is required at the conclusion of the conference to prepare a summary of the conference which will be sent to all conferees. The summary, according to law, must include the following:

(1) Occurrence of pollution of interstate waters subject to abatement under the Federal Act;

(2) Adequacy of measures taken toward abatement of pollution; and

(3) Nature of delays, if any, being encountered in the abatement of pollution.

Where the situation does not lend itself to the covering of all these points at one session of the conference, we have held conferences in two sessions; the second session to be held on the call of the chairman after a reasonable opportunity has been given to develop additional information. If this situation should be one of this type it is suggested that consideration might be given to designating the proceedings today as the first session of the conference and scheduling a second session in the future.

Now, a word about the procedures governing the conduct of the conference -- Mrs. Price is making a stenographic report of these proceedings for the purpose of aiding us in preparing a summary and also providing a record of what is said and done here. We will make copies of the summary and transcript available to the conferees.

An agenda has been provided for the conferees. The agenda is to aid us in directing our discussion toward the points required to be covered by law. However, the agenda can be adjusted to meet particular situations as they arise.

All the conferees will be called upon to make statements. The conferees, in addition, may call upon the participants they have invited to the conference to make statements. At the conclusion of such statements the conferees will be given an opportunity to comment or question, and at the conclusion of the conferees' comments or questions, I may ask a question or so, too.

This procedure has proved effective in developing a clear statement of the problem and reaching agreements on equitable solutions.

Now, for the first presentation, I would like to call upon Mr. Keith Krause, of the Dallas Office of the Public Health Service. Before you begin, I should like to indicate that we are having a transcription of the conference made, which will be made available to the States. To aid in making the transcript we are also having a tape recording made, and we have one microphone. Now I would suggest that participants come up in front to these chairs at the table; if we have some difficulty in getting the tape recording we will adjust the mike so you can be heard.

MR. KRAUSE: Thank you, Mr. Chairman. I should like to present the general statement, to be followed immediately by a more detailed statement by Doctor Tsivoglou, Chief of Technical Water Pollution Research, Robert A. Taft Sanitary Engineering Center, Cincinnati. I would like to describe the area under consideration.

A. Physical Description

1. The Animas River rises in southwestern Colorado above Silverton. It flows southerly for approximately 100 miles to its junction with the San Juan River at Farmington, New Mexico. It crosses the Colorado-New Mexico State line near Riverside, New Mexico, a point approximately 30 miles from its mouth. The Florida River is the only main tributary of the Animas and it lies wholly within the State of Colorado.

2. The river basin has an over-all length of approximately 100 miles, 70 of which are in Colorado and 30 miles in New Mexico. The basin is approximately 20 miles wide at its widest portion. The upper part of the basin from Durango, northward is rugged, mountainous country. Below Durango the land is rolling and there is flat land along the stream which is irrigated.

3. Annual rainfall in the basin varies from approximately 15" a year in the southern portion to about twice this amount in the northern mountainous part of the basin. Stream flow gaging stations are located at Durango, Colorado, Cedar Hill, New Mexico, and Farmington, New Mexico. The average daily flows at these three stations are 890, 943, and 1,000 c.f.s. respectively. Minimum daily flows at these stations have been recorded at 94, 90, and 5.4 c.f.s. respectively.

4. The principal towns in the basin and their 1950 populations include the following:

Silverton, Colorado	1,375
Durango, Colorado	7,459
Cedar Hill, New Mexico	200
Aztec, New Mexico	885
Farmington, New Mexico	3,637

Since 1950 the population has increased greatly in the basin. There are now approximately 22,000 people at Farmington, 6,000 at Aztec, and 11,500 at Durango, Colorado. Oil and gas developments in New Mexico have been largely responsible for the large increase of population in Aztec. Uranium mining to the west of the Animas River Basin has brought people to Durango, Colorado. Further industrial expansion is imminent and much of it will be dependent on an ample supply of safe, good quality water.

5. Principal occupations include: farming, oil and gas production and associated service industries, mining, ore processing and miscellaneous occupations.

Numerous mines (lead, silver and gold) are located in the upper portion of the basin between Durango and Silverton, Colorado. Uranium ore is brought into Durango for processing. Industrial activity in New Mexico includes extensive oil field developments in an area extending northwest and southeast of Aztec,

New Mexico. Milling and ore processing is carried on at several mills in the Silverton area.

Agricultural activities include the irrigated farming of river valley lands from Durango southward.

B. Water Uses

Surface water supplies serve the towns of Silverton and Durango, Colorado. Silverton draws water from Mineral Creek to serve 1,375 inhabitants. Durango draws water from the Florida River to serve its population of 11,500. In New Mexico, Aztec draws water from the Animas River to serve a population of approximately 6,000. Farmington also draws water from the Animas River to serve a population of 22,000. Both of these latter towns divert water from the river through channels and Farmington has recently provided facilities to draw supplemental water from the San Juan River during critical times.

C. Plans for Development of Increased Water Uses by the Bureau of Reclamation.

The Bureau of Reclamation has planned several projects in the San Juan River Basin area. The operation of the Hammond and Navajo Projects will at certain times stop the flow of water in the San Juan River between the Hammond Project and the mouth of the Animas River (Farmington) except for irrigation return flow water. A project (Animas-LaPlata Diversion) is currently being studied in the Animas River Basin which would divert flow from the Animas River above Durango for irrigation uses. Water is of utmost importance to the health, welfare and economy of this area.

D. Description of Problem

1. Sources of Pollution: Durango, Colorado is the most significant source of organic pollution of an interstate nature. Remedial measures are planned by Durango as indicated by recently submitted plans for a new secondary sewage treatment plant to cost an estimated $645,640. The city has applied for a Federal construction grant for this facility. Aztec, New Mexico has let a contract for construction of a new secondary sewage treatment plant to cost $253,059.40. Under the provisions of Public Law 660, 84th Congress, a Public Health Service grant of $63,429 was approved in March 1957. One of five ore processing industries located in the Silverton area is in operation and discharges final wastes to the Animas River after treatment in tailings ponds. A meat packing plant and a uranium processing plant are located at Durango.

2. Nature of Pollution: Organic pollution from the town of Durango, Colorado is expected to be rectified when new treatment facilities are built for municipal wastes. Radioactive wastes from the Vanadium Corporation of America plant at Durango are discharged to the Animas River, and there is reason to believe that downstream water uses such as public water supply and crop irrigation may be adversely affected by these wastes.

Dr. Berwyn F. Mattison, Member, National Advisory Committee on Radiation, has aptly expressed the problem of radiological hazards in relation to public health in an article appearing in the American Journal of Public Health, January 1958. Doctor Mattison states, "Is radiation a major public health problem? We have seen that a number of health agencies believe that it is. But what criteria must we apply to make this determination? First, the extent of the problem merits public

consideration. There is not one among us who will not, throughout his lifetime, be affected by cosmic radiation, and most of us at some time will be affected by one or more of the following - radiation received in a physician's office or a dentist's office, radiation received while working in certain industries, radiation received through ingestion of foods and, of course, the new hazard, its extent not yet clear, radiation from fallout produced by testing of nuclear weapons.

"Second, is this a problem which can be handled adequately by each individual? Obviously it is not, and some concerted community-wide action will be required if radiation hazards are to be adequately controlled.

"Third, are the hazardous conditions produced through radiation correctible to any significant degree? Here our knowledge is much more recent, but it certainly has been well established by the Atomic Energy Commission that a great deal of work with massive sources of radiation can be done safely, providing meticulous care is exercised in utilizing protective devices. Furthermore, our brief experience in Pennsylvania has shown that inspection of sources of radiation in daily use across the Commonwealth can repeatedly uncover needless (and frequently unrecognized) sources of stray radiation which are correctible on a practical and economical basis.

"Using these three criteria, alone, I believe that the place of radiologic health as a major public health problem has been demonstrated."

3. Available Information on Stream and Wastes:

Table 1

WATER QUALITY CHARACTERISTICS* - 1955 1/

Radioactivity uuc/l

Sampling Point	Gross Alpha Susp.	Diss.	Total	Gross Beta Susp.	Diss.	Total	Soluble Radium
	in uuc/l						
Durango, Colo.							
Direct effluent	33,200	10,000	43,200	2,300	14,000	16,300	76
Tailings Pond effluent	300	2,900	3,200	2,300	5,200	7,500	25
Animas River							
Above Durango	2	0	2	4	28	32	0.2
Below Durango	7	27	34	22	4	26	3.3

*Grab samples

Average Natural Background Radioactivity	
Gross Alpha (Dissolved)	10 uuc/l
Gross Beta (Dissolved)	24 uuc/l
Soluble Radium	0.3 uuc/l

1/ Report of a "Survey of Contamination of Surface Waters by Uranium Recovery Plants", Sept. 1955, Tsivoglou, Bartsch, Rushing, Holaday.

Table 2

RADIUM CONTENT OF ANIMAS RIVER NEAR DURANGO, COLO.
(Colorado-New Mexico) 2/

Location	Soluble Radium		
	Water, uuc/l	Stream biota, uuc/gm	
		Plant	Animal
1950			
Above Durango	0.20	-	-
Below Durango	4.5	-	-
1955			
Above Durango	0.20	6	6
Below Durango	3.3	660	360

2/ (Ibid)

Organic and bacterial pollution control should not present serious problems. The full extent of the radiation exposure to users of Animas River water still must be evaluated. Very limited studies conducted by the Public Health Service in 1955 indicated that the gross Alpha concentration below Durango was 34 uuc/l in the water; 850 uuc/gram in the river mud, and 2600 uuc/gram ashed weight, in plant life of the stream. Corresponding increases occurred for gross Beta activity. Radium was concentrated by a factor of 100 in the stream biota. If food crops irrigated by Animas River water would show a similar increase, this would constitute a serious problem.

In summary, the degree of exposure and the scope of the problem should be delineated at the earliest possible time. Sufficient data for this purpose is not now available. A survey to secure the needed information should be started immediately. If the indications of excessive discharges of radioactive wastes are confirmed, specific corrective action should be initiated at once.

MR. STEIN: Thank you, Mr. Krause. Doctor Tsivoglou, would you continue the statement?

DOCTOR TSIVOGLOU: Introduction and Background. On the basis of the limited information now available, radioactive waste discharges from the uranium refinery at Durango, Colorado, appear to present a significant problem in terms of legitimate and desirable downstream uses of the Animas River. Analysis of this problem is complicated, however, by other radioactive contamination of the local environment, and by the variety of ways in which the radioactive substances involved can be ingested. As a result, a survey to evaluate total internal radiation exposure in the Durango-Farmington area is needed before appropriate remedial measures for waste disposal by the uranium mill can be determined. However, as these studies progress, interim remedial measures will probably suggest themselves, and can be effected at once.

In most areas of the country, and in this area in particular, there is not sufficient water available for all desirable uses. It is therefore necessary to use the available water as efficiently as possible, and to expect it to be used and re-used for various purposes. Such uses include, for example, domestic water supply, irrigation, recreation, stock watering, industrial process

water supply, and waste disposal. The Animas River below Durango is used for at least four of these purposes. It is the source of domestic water supply for Aztec and Farmington, New Mexico, or some 28,000 people, and a portion if its flow is diverted between Durango and Farmington to irrigate some 26,000 acres of agricultural land; its recreational use includes fishing, and it serves for stock watering and waste disposal.

It is important to distinguish between "natural" or "background" radioactivity, and that which is added artificially as pollution. Natural waters have always contained a small amount of radioactivity, entirely derived from radioelements such as uranium, thorium, radium, and potassium-40 that occur naturally in the earth's crust. (1) Although there are few exceptions such as hot springs, this natural radioactivity of surface and ground waters is generally considerably less than the permissible amount.(2) The background radioactivity of the Animas River is low - for example, its dissolved radium content is no more than 10 percent of the permissible amount (see Table I). Since the advent of nuclear weapons testing there has been a general increase in the radioactivity of the environment. Nuclear industry such as uranium refineries or atomic power plants may further add to local environmental radioactivity by discharging radioactive wastes.

Radioactive materials that are ingested or inhaled result in internal radiation exposure, as contrasted to the external exposure that results from a source of penetrating radiation located outside the body. On ingestion, certain radioelements tend to accumulate in specific body organs - for example, radium and strontium accumulate in the bones, while iodine goes to the thyroid gland. Such radioactive materials irradiate the surrounding tissue until they have decayed or have been biologically eliminated. As regards radioactive wastes from the Durango uranium mill, we are concerned with internal radiation exposure of the local population, and the remainder of this statement considers only internal exposure.

In determining criteria for the safe disposal of radioactive wastes it is also important to consider <u>all</u> means by which the local population group is exposed to radiation. The effects of radiation exposure are cumulative, and the total exposure of a population is much more significant than the fraction of it associated with one particular source such as drinking water. An individual or a community may drink slightly contaminated water and milk, eat slightly contaminated food, and breathe slightly contaminated air. A portion of the individuals may during their working hours inhale or ingest somewhat higher amounts of radioactive materials as a result of their occupation in the nuclear industry. It is the <u>total</u> exposure that has real significance, and it is important to examine each source, such as a domestic water supply, in the light of the total radioactivity intake from all local sources. While any <u>individual</u> exposure, such as that from the domestic water supply, may be lower than the maximum allowable, the total radiation exposure from all sources may exceed that regarded as safe.(2)

In the Durango-Farmington area there are several sources of internal radiation exposure. Data that will be presented later indicate a certain amount of dissolved radium and other radioelements in the Animas River below the Durango uranium refinery. Green plants will concentrate and accumulate radium to some unknown extent from irrigation water that contains radium. Animals, domestic and game, that drink from the river and graze on irrigated lands may also accumulate some radium. The river fish may contain small quantities of these wasted

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radioelements. Radioactive suspended solids, if discharged into the river, may to some degree contaminate water treatment equipment such as filters in downstream water treatment plants. It may well be that, taken individually, any of these paths of human radiation exposure is small. Nevertheless, they are additive, and their total effect may be significant.

In addition to the above sources of exposure, one must consider the human intake of radioactive materials that are distributed by virtue of nuclear weapons tests. The resulting fission products are distributed into the air, soil, water and all phases of the environment. The regional distribution of these materials is dependent upon frequency of weapons tests, location of the test site, local and general meteorological conditions, and other factors. Although many radioelements are so distributed, our concern here is mainly with radioactive strontium, because its behavior and effect is similar to that of radium. Thus, in terms of exposure of the population of the Durango-Farmington area, some radioactive contamination of water, fish, soils, crops, milk, etc., has resulted from the worldwide testing of nuclear weapons. The resulting radiation exposure must be added in some cases to that which comes about from the local uranium refinery.

I do not intend to imply by all this that the people of the Durango-Farmington area are being exposed to dangerous amounts of radioactivity. I have attempted to list the possible sources of exposure, and to indicate that we do not have adequate knowledge as to the actual exposure contributed from each source. The degree of total radiation exposure cannot be known until considerably more data are obtained.

Past Studies and Available Data

The first brief investigation of stream contamination by uranium refineries was performed in October 1950 by the Public Health Service at the request of the interested States.(3) Samples of river water were collected at locations above and below each of four operating mills, of which the Durango mill was one. The samples were analyzed for radium, as this was considered the most significant radioactive waste product. The analytical results are shown in Table I. This survey was a brief reconnaissance intended only to roughly determine existing radium concentrations in the Animas River.

In the fall of 1955 a second brief survey was performed on streams in the vicinity of eight operating mills.(5) The Durango mill was included. At this time samples of river water, bottom mud, and biota (algae, insects) were collected at locations immediately above and below the mill and analyzed for gross radioactivity and for radium. Samples of the effluents from the mill were also collected and analyzed at this time. Results are given in Table I for the water samples and effluents, and in Table II for the mud and biological samples.

The effluents from the mill were at quite small flow rates at the time of the 1955 survey, hence, although their radioactivity was high relative to the natural stream radioactivity, the dilution effect was great, as indicated by the results obtained at the downstream sampling point. Both sampling runs indicated a gain in the dissolved radium content of the river by a factor of about 20.

The biological and mud samples are cumulative as contrasted with the instantaneous samples of flowing river water. Thus, they yield something more

than a momentary indication of stream radioactivity. Rather they represent some unknown period of accumulation of radioactive material discharged from the mill. These data indicate a gain by a factor of about 100 in the radium content of the stream biota. Radium was not determined at this time for the mud samples.

Table I

Radioactivity of Water Samples
(Animas River near Durango, Colorado)

	Radioactivity, uuc/l.						
	Gross Alpha			Gross Beta			
Location	Susp.	Diss	Total	Susp.	Diss.	Total	Dissolved Radium
1950							
Animas River Above Mill	--	--	--	--	--	--	0.20
Animas River Below Mill	--	--	--	--	--	--	4.5
1955							
Animas River Above Mill	2	0	2	4	28	32	0.2
Animas River Below Mill	7	27	34	22	4	26	3.3
Direct Effluent from Mill	33,200	10,000	43,200	2,300	14,000	16,300	76
Tailings Pond Effluent from Mill	300	2,900	3,200	2,300	5,200	7,500	25

Table II

Radioactivity of Mud and Biological Samples, 1955
(Animas River near Durango, Colorado)

	Radioactivity, uuc/gm.							
	Mud		Algae			Bottom Insects		
Location	Gross Alpha	Gross Beta	Gross Alpha	Gross Beta	Radium	Gross Alpha	Gross Beta	Radium
Animas River Above Mill	16	71	85	200	6	100	260	6
Animas River Below Mill	850	550	2,600	8,600	660	1,500	4,800	360

Flows in the Animas River at Durango were 250 cfs in 1955 and 220 cfs in 1950 at the time of sampling. These data indicate an approximate discharge of 2.0 milligrams per day of dissolved radium from the Durango refinery.

I would like to emphasize that the data contained in Tables I and II are not considered representative of any long period of time. They represent only isolated samples, and cannot be considered, for example, as average results for any significant period of time. The annual or monthly average radioactivity discharges from the Durango uranium refinery may be either somewhat higher or lower than these data, and we have no knowledge of this at this time. The data do indicate a definite gain in stream radioactivity below the mill. The significance of this gain is in doubt because of the very few analytical survey results that are available now. We are concerned with radiation exposure representative of a substantial period of time, rather than with a few not necessarily representative isolated samples.

No data are available that specifically regard the radiation exposure of people of the Durango-Farmington area as the result of fallout from nuclear weapons tests. As has been indicated, this is a part of the total radiation exposure picture, and must be added to the exposure from the local source of pollution. Radiostrontium contamination of this area may be relatively low or high - as no data are available for this area, no conclusion can be reached on this point, except that information is needed.

The limited available data indicate that existing levels of radium alone in the Animas River may be at or near recommended safe concentrations for public water supplies. However, allowance must also be made for other paths of radium intake and for the presence of other hazardous radioelements. It is therefore not possible at this time to evaluate the full public health significance of radioactive waste discharges to the Animas River. Considerably more specific data must be obtained before adequate and proper waste control measures at the Durango mill can be recommended.

Existing Standards

Maximum Permissible Concentrations (MPC's) in air and in domestic water supply for most radioelements are listed in Handbook 52, National Bureau of Standards,[2] and these are the basic recommendations for protection against excessive internal radiation exposure. An addendum[4] to Handbook 59, National Bureau of Standards indicates that the concentrations listed in Handbook 52 represent allowable internal exposure for radiation workers, and should have a safety factor of ten applied for protection of the general population outside the controlled area, or industrial site. These MPC's refer to the amount of any listed radioisotope that can be ingested in domestic water supply continuously over a lifetime without producing any readily detectable biological damage.

Radium is a long-lived alpha emitter that deposits in the bones. It decays successively to several other elements, or daughters, that are also radioactive. The MPC for radium plus one-half of the equilibrium amounts of its radioactive daughters in public water supply is 4 micromicrocuries per liter (uuc/l). In terms of radium alone, that is without any of its radioactive daughters, the figure is in the neighborhood of 2 uuc/l. This is the lowest of all of the MPC's listed in Handbook 52 for domestic water supply, and in these terms radium is considered the most hazardous of all of the listed radioisotopes.

Strontium-90 also decays to a radioactive daughter, yttrium-90, and the MPC for strontium-90 plus an equilibrium amount of yttrium-90 in domestic water supply is 80 uuc/l. Strontium is also relatively long-lived, emits betaparticles during decay, and deposits primarily in the bones. It has next to the lowest of all of the Handbook 52 MPC's in domestic water supply, being second only to radium in this regard.

The basic principle of protection against internal radiation exposure is to place an upper limit on the amount of exposure that can be allowed for the affected organ. This has the effect of placing an upper limit on the total allowable intake of any particular radioisotope. Thus, if radium were the only radioisotope involved here, and if the domestic water supply were the only means of human intake, then the domestic water supply could allowably contain as much radium as is specified by its MPC. If, however, radium is ingested via several paths such as domestic water supply and crops that have radium in them, then the total intake of radium must be considered. Thus, if the crops contained a relatively large quantity of radium, the content of the water supply would have to be severely limited, at some level well below the MPC. Conversely, if the domestic water supply were to contain the maximum permissible amount of radium, then intake via other paths such as food would result in exceeding the safe radiation exposure.

The same principles apply to combinations of radioisotopes that affect the same organ. To quote Handbook 52: "Often a person is subject to radiation exposure from several different sources simultaneously. In any case, the maximum permissible concentration of radioisotopes in air and water and the external radiation should not exceed values that will permit an exposure of 0.3 rem/week to any part of the body except the epidermal skin layer." Thus, because radium and strontium both affect the bones, they must be considered together as a source of internal radiation exposure, and the allowable intake of one is directly affected by the presence of the other. For example, if a domestic water supply were to contain the maximum permissible amount of strontium-90 then no radium could be permitted in it, and vice versa; or, if the water supply contained half of the MPC of strontium-90, then only half of the radium MPC could be allowed. The intake of either of these radioelements by other paths such as food or milk would further restrict the allowable intake via the domestic water supply.

As we have seen, there are a number of possible paths of intake of radium and of strontium-90 in the Durango-Farmington area, but there is very little actual data regarding the extent of human intake by these various routes. It is not possible at this time to estimate the total intake with any acceptable accuracy. Only by means of additional sampling and analysis can we accurately assess the degree of local radiation exposure and the contribution made by radioactive waste discharges from the uranium refinery at Durango, Colorado.

Proposed Fact-finding Survey

In view of the present uncertainty as to the amount of radiation exposure in the Durango-Farmington area, and the resulting uncertainty regarding acceptable levels of radioactive waste discharge to the Animas River from the uranium refinery at Durango, Colorado, the fact-finding survey outlined below is suggested for immediate performance. The objectives of the survey are:

(a) To evaluate the internal radiation exposure to radium and strontium-90 in the Durango-Farmington population area, and the portion of this total

exposure that results from radium and other waste discharges from the Vanadium Corporation of America uranium refinery at Durango, Colorado.

(b) On the basis of the above evaluation, to assess the interstate pollutional aspects of the uranium refinery waste discharges, to estimate an allowable upper limit for waste discharges, especially radium, from this refinery, and to suggest any necessary remedial measures.

In keeping with the aim of accomplishing the above objectives as quickly as possible, the following tentative sampling schedule is proposed; as information accumulates, sample types and frequencies will be altered to best accomplish the foregoing objectives:

(a) Raw water and tap water at Aztec and Farmington, New Mexico; these samples to be composited weekly during periods of low stream flow and monthly during other periods.

(b) Filter sand from the sand filters at the Aztec and Farmington, New Mexico, water plants; monthly, before cleaning the filters; other samples indicative of contamination of the water plant equipment, as desirable.

(c) Fruit and/or vegetables from three or four representative farms that use the Animas River in important degree for irrigation; to be collected at a frequency in keeping with crop development, possibly monthly.

(d) Farm topsoil from the above farms; to be collected before and following the irrigation season and at desirable intermediate times.

(e) Milk and possibly other food samples; to be collected monthly and composited if feasible.

(f) Animas River samples of water at stream sampling stations located immediately above and below the Durango refinery, at the Colorado-New Mexico boundary, and probably at one or two additional stations in New Mexico; these samples to be composited if at all possible and to be collected monthly and possibly more frequently during low flow periods.

(g) Animas River mud samples: to be collected in representative fashion monthly at the stations noted in (f).

(h) Animas River biological samples: to be collected in representative fashion monthly as available at the stations noted in (f); to consist of algae or plankton and bottom insects; fish samples to be collected quarterly at the station above the refinery, at a representative location below the refinery and in New Mexico below the Colorado-New Mexico boundary.

(i) Effluent samples from the Durango refinery; to be composited and collected monthly, to coincide if possible with the river sampling schedule.

(j) Precipitation samples (rain and snow); to be collected as available at Durango and Farmington.

In addition to the foregoing routine sampling schedule, several brief more intensive surveys should be made. These surveys might be of two to four weeks duration, and should be timed to coincide as well as possible with both

seasonal and low flow patterns. During these surveys more extensive data on all of the above sample types should be obtained as base material for interpretation of the routine but infrequent sampling outlined above. The first and most extensive of these surveys should be performed during the summer of 1958.

During one of the above field surveys a study of the uranium refinery process should be carried out. At this time, probably the summer of 1958, bioassay studies of the toxicity of potential and actual refinery effluents should also be performed.

The foregoing samples should generally be assayed for gross radioactivity, for radium, and for strontium-90 on a selected basis. Uranium analysis is probably not necessary except for a few isolated samples; the MPC for uranium is quite high, and reason as well as the limited data available indicate that uranium releases as waste are relatively quite small.

Many of the foregoing types of samples are cumulative by nature, and it is for this reason that some types can be grab samples at relatively infrequent intervals.

The duration of the routine sampling program, because of seasonal water uses and because of the nature of radiological hazards, should be one year with a somewhat reduced program extending into a second year. It is anticipated, however, that considerable significant data should be available well before the completion of the program outlined.

Sampling on a routine basis should commence as soon as possible. It is expected that the suggestions of other agencies as well as field circumstances may to some extent modify the course of the investigation. It is suggested that the operators of the Durango refinery and the U. S. Atomic Energy Commission, as well as the States of Colorado and New Mexico, be invited to cooperate and participate in the studies.

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MR. STEIN: For the purpose of the record, I notice that you have several tables and a bibliography. I would suggest that, if you can, give a copy of your tables to Mrs. Price and she will insert the tables and bibliography in the appropriate places in the record.

Before we continue with comments from the State agencies, we should like to have a brief pause for a photograph, which I understand is desirable because we have some folks here who would like to take some pictures. Let's take a coffee break for ten minutes.

RECESS

MR. STEIN: May we reconvene? Before we get on I would like to introduce Doctor Weber, Regional Medical Director, Public Health Service, Denver, who has just arrived. - Doctor Weber.

At this point I should like to call upon the conferees and ask if there are any comments or questions that they wish to make or raise relative to the statements of Mr. Krause or Doctor Tsivoglou. Colorado? - New Mexico? Do you have any questions or comments?

DOCTOR CLEERE: I have a question, Mr. Chairman. Is it definite that the study referred to by Doctor Tsivoglou will begin this summer? I have reference to the study of the Animas River.

MR. STEIN: Yes, it is definite that this study will begin this summer. I think if the study is suitable to the other conferees, definitive arrangements probably will be made at this time and subsequent to this meeting. Now, as I have indicated, the Public Health Service, in interstate pollution problems, recognizes its responsibilities, and once having decided to get started, have a way of going on to a definitive conclusion. The Public Health

Service has budgeted and set aside money and has committed personnel from its own staff, to do this, as will be developed subsequently. We are hopeful for as much participation as we can get from the States concerned, but in any event we will definitely plan this subject to further consideration.

Are there any other questions?

DOCTOR CLEERE: Will this be a comprehensive study?

MR. STEIN: Yes, within reasonable limitations. I might indicate to many of you folks the magnitude of the type of study we contemplate here. Because of the significance of this problem, and because of the fact that this, I think, is the first time any State or Federal agency has really considered the problem of radioactivity as a pollutant, in an active case, the Public Health Service has definitely set aside $40,000 for this study. Now, I think that is a relatively minimum cost in that we are not thinking in terms of the regular salaries of the group who will participate in this project as a greater part of their job. So, I think we will have a fairly complete evaluation of the problem.

DOCTOR CLEERE: Would you venture a guess as to the duration of the study?

DOCTOR TSIVOGLOU: Almost all of the regulatory statutes indicate that you should be concerned with the available exposure to radium for a year or longer period. For this reason, I think the routine sampling program probably will have a duration of possibly a year to a year and a half. I believe the intensive work that should be done this summer should make available enough data within, say, six or seven months, so that any necessary remedial measures could be considered about that time. Does that answer it?

DOCTOR CLEERE: Yes. I have one other question, Mr. Chairman. Will the timing of the second conference be related to the findings of the survey?

MR. STEIN: The proposal we have to make is that if Doctor Tsivoglou's suggestions are considered, very little would be accomplished by the conference without additional data; and what we are faced with is a situation where we have to gather more data now. However, we are also faced with a fact; that is, the possibility that the State of New Mexico may be subject to an interim hazard, being the recipient of a radioactive pollutant. During the survey the cumulative effect of the pollutant may so rise that it may take a long time to get rid of it. So, what we are thinking in terms of, as well as the study group, is that they would make recommendations or positive suggestions, even though these may be interim suggestions; that we then consider reconvening the conference to decide whether conferees would recommend action based on these recommendations, if that were so warranted. This development has arisen in the last few days, and if this is the case we will proceed along this line.

To give effect to New Mexico's suggestion, we will call another session two to six months from now and see if we can agree on interim remedial measures and related recommendations. Later, we will call a third session to see what recommendations the conferees want to make for a long-range solution of the problems.

I would like to indicate as far as Public Health Service is concerned, the fact that this conference has been convened does not mean the problems are

all going to be resolved. The States may very well continue to see what is occurring and the remedial action that may be indicated, if remedial action is called for.

Does that answer the question?

DOCTOR CLEERE: Was it your intention at this time to have a general discussion period; meaning, is it in order for other questions to be asked from the other representatives from Colorado, or any member of the audience?

MR. STEIN: At this time perhaps Mr. Gahr may have a question to ask. These folks will have an opportunity to speak after the conferees have given their statements.

MR. GAHR: I will defer mine -

MR. STEIN: Do you have any questions or comments, Doctor Leland?

DOCTOR LELAND: None except this; - your study is going to be limited to an area between Durango and Farmington, as I understand?

MR. STEIN: Doctor Tsivoglou, is that correct? Is the study to be limited to an area from Durango to Farmington, for this purpose?

DOCTOR TSIVOGLOU: I would say that unless there are very definite problems, depending largely, I should think, on possibilities of more water or less water, as the case may be; then the survey would center around the area concerned.

DOCTOR LELAND: I would like to repeat Doctor Cleere's question. When do you think this study will get underway?

DOCTOR TSIVOGLOU: I would like to see it get underway as soon as possible. I would like to see some of the routine sampling started within a month, and I would like to see the intensive work started in July.

DOCTOR LELAND: You would of course call upon the two States to assist in any possible manner -

DOCTOR TSIVOGLOU: Yes, to some extent we would depend on assistance from the States.

MR. STEIN: We would like to have assistance from the States, this being a cooperative State-Federal study.

DOCTOR LELAND: That is what we also should desire.

MR. CALDWELL: The only other point I would like to make, is to confirm very fully what Doctor Cleere has established, that recommendations for corrective action could be made in the early stages of the study, if so indicated, as data is developed. Because of the nature of the problem we feel it is important that recommendations be developed in the interim period before the final report is made.

MR. STEIN: Fine. May we then call on Doctor Leland, Director of Public Health, New Mexico, for a statement from New Mexico?

DOCTOR LELAND: I should like to just re-affirm that which you have heard, which I think points out the significance of a potential hazard; one which does concern the State of New Mexico as well as the State of Colorado. For the technical side of the pollution problem in addition to the radioactive aspect which we have discussed, I should like to have Mr. Charles G. Caldwell, our State Sanitary Engineer, discuss the matter.

MR. CALDWELL: Thank you, Doctor Leland.

The Animas River flows through Durango, Colorado, and then across the State line into New Mexico. About fifty miles below Durango, Aztec, New Mexico, with a population of about 6,000 derives its drinking water from the river after treatment in a conventional water treatment plant which includes coagulation and filtration. Farmington, a town of about 22,000 population, is located at the confluence of the San Juan and Animas Rivers, about fourteen miles below Aztec; and again, the river water after conventional type treatment, is used for domestic purposes. The waters of the Animas co-mingled with the San Juan River flow are used by Navajo Indian facilities and private users as the San Juan continues on out of New Mexico and into Utah, and then into Arizona.

These river flows are of tremendous importance to the economic development of this area. Gas, oil and mining developments have resulted in a tremendous population and industrial gorwth, with the end not yet in sight. In fact, all indications are that the rate of activity will continue to increase for several years to come. This will necessitate increasing utilization of waters from both the Animas and San Juan Rivers, both above the confluence and below. As a part of our water pollution control program, designed to maintain these waters in satisfactory condition for further downstream multiple use, the Town of Farmington completed a new primary and secondary sewage treatment plant. The Town of Aztec project, now underway, is designed for the same purpose.

If the quality of this water is to be suitably maintained, however, consideration must be given to upstream factors where discharge of municipal and industrial wastes may be causing degradation.

In this connection it came to our attention, as a result of a report under date of November, 1954, entitled, "Comments of the U. S. Public Health Service on the Status Report of the Animas-La Plata Project, Colorado and New Mexico", Department of Health, Education and Welfare, San Francisco, published April 4, 1955, that the Town of Durango was using primary sewage treatment only. The report states that the Colorado State Health Department had advised replacement of the treatment facilities at that time. It is our understanding that this has not been done, and that the town has grown considerably, thus further overloading this inadequate treatment plant.

The report also indicates that untreated domestic sewage is discharged into the Animas at Silverton, a condition which we understand has not been corrected.

There has also been some question on the part of the San Juan County Health Department of New Mexico as to the location of municipal dumping areas on the lower Animas in Colorado, and the possible effects on the receiving stream. Although secondary to the municipal sewage disposal problems outlined above, this matter is worthy of some investigation to either justify corrective action or dispel cause for further concern.

The primary industrial waste problem centers around a uranium ore processing mill located on the outskirts of Durango. The Summary Report on Quality of Interstate Waters - Animas River, developed by the Water Supply and Water Pollution Control Program of the Public Health Service, January, 1958 shows that a grab sample taken from the tailings pond effluent had a soluble radium content of 25 uuc/l, another sample showed 0.2 uuc/l above Durango, while a third sample taken below Durango, which would be after dilution, had a level of 3.3 uuc/l. This may be especially significant, as it is our understanding that the maximum level in the effluent should not exceed 4 uuc/l. The flow in the Animas River at Farmington varies from around 5 cfs to over 20,000 cfs; consequently, there is not a uniform, year-around dilution factor.

Although radium is a primary cause for concern, some thought must be given to gross Alpha and Beta activity. The 1955 report lists a total gross Alpha below Durango at 34 uuc/l, and a total gross Beta of 26 uuc/l.

The Colorado State Department of Public Health which has shown full understanding of our concern and has given full cooperation, informed us that three samples were picked up from the Animas River in the vicinity of Durango in June, 1957. In Sample R-2 Beta activity was reported at 260 uuc/l. A sample picked up in February, 1958, by this agency at a point at least one mile below the mill discharge, had a suspended activity of 158 uuc/l, and a dissolved activity of 26 uuc/l.

We do not feel that the results of analyses made to date are conclusive, but we do believe that the data collected so far, from all sources of information, is significant in pointing out the existence of a problem which should be investigated before it develops further or causes undue pollution to the detriment of downstream users. In this connection the industrial waste problem can be divided into two parts. One, the current levels of chemical and radioactive waste materials being discharged into the river; and two, the location of a tailings pond, containing considerable quantities of radium, in close proximity to a river used as a source of drinking water. The significance of these two factors could be of considerable importance in terms of long-range public health protection.

After careful consideration of all of the above, and because of the continued rapid development of this area which to a great extent depends upon an assured supply of acceptable water from the Animas and San Juan Rivers, the New Mexico Department of Public Health has formally requested the Department of Health, Education, and Welfare, Public Health Service, Regional Office, Dallas, Texas, to arrange for this conference with a view to providing an opportunity for free discussion of all salient points by all agencies concerned, and further to request that Public Health Service institute a water pollution survey of the Animas River, such survey to include biological, chemical physical and radioactive waste studies as well as municipal and industrial plant surveys and evaluations; all of the proposed work to be directed toward protecting the quality of the water of this interstate stream.

MR. STEIN: Thank you, Mr. Caldwell. Do you folks in Colorado have any comments or questions on the New Mexico statement?

MR. GAHR: Just so that we fully understand each other -- by conventional water treatment, exactly what do you mean by rapid sand filters, coagulation, etc., the complete process? In your opinion do you feel that this type of water plant

processing, conventional treatment, can cope with unconventional types of wastes that contaminate the water?

MR. CALDWELL: I do not want to say that it will cope with radioactive wastes, I have not seen enough evidence to indicate that.

MR. GAHR: You mention that Aztec and Farmington have secondary treatment for their domestic sewage. When their new plants are constructed, did you state that they will both have primary and secondary sewage treatment for their domestic sewage?

MR. CALDWELL: That is correct.

MR. GAHR: Thanks.

DOCTOR CLEERE: The studies conducted to date by the Colorado Department of Public Health are certainly inadequate as far as any conclusive findings are concerned.

MR. KRAUSE: As Mr. Caldwell mentioned, concerning the possible rapid growth of the industrial and economic potential of the San Juan-Animas basins; I should like to have him enlarge upon that as to what the potential for this river appears to be.

MR. CALDWELL: That area is really one of the last major areas for development, I could say, in the West; at least it is one of the last large areas of New Mexico where there are still water rights on the Animas River that can be obtained for irrigational and industrial purposes. There has already been, as I have noted, a tremendous increase in population in Aztec and Farmington as a result of the oil and gas developments. You may have read in the papers that there is another pipeline being approved, and another one applied for. In addition, today we have a report by a construction company which states that they have applied for 139,000 acre feet of water annually for industrial development. Included in the suggested industrial developments are Nitric Acid production, Manganese mining, electric generating plants, possible food processing and other activities.

The way it works out, we can expect that the area from Gallup on up through Farmington and Aztec is going to really develop. It is going on right now, and that means more and more water use for those industries already there and those that will be established.

MR. STEIN: Mr. Krause, do you have any more questions?

MR. KRAUSE: No.

MR. STEIN: May we call on the Colorado State Department of Public Health at this time? Doctor Cleere, would you speak on the sources of pollution and measures of control being instituted?

DOCTOR CLEERE: Mr. Chairman, before proceeding, and if it is in order, I would like to call on Mr. Gahr to introduce other Colorado representatives who are present today for the conference.

MR. STEIN: That would be fine, but we suggest that they speak later as we have a place on the program for the other participants, and if you think

it would be appropriate, we can call on them then.

DOCTOR CLEERE: Yes, that will be all right. I wish to say that the statement I am about to read was prepared by Mr. William Gahr, Director of the Division of Sanitation, Colorado State Department of Public Health. There are copies of this statement available, and I will ask Mr. Gahr to distribute copies at this time.

An inspection of the Animas River drainage area upstream of the Colorado State line was made in April, 1958, to determine the general nature of pollution going into the Animas River.

The Animas drainage area begins above Silverton, Colorado, and extends south into New Mexico. In Colorado the basin is approximately seventy-five (75) miles long and fifteen (15) miles wide.

Pollution in the Animas River results from domestic sewage and industrial wastes which receive varied stages of treatment.

Silverton, Colorado, (population 800) discharges raw domestic sewage into the Animas River from approximately 600 people connected to the sewer system. The location of the open city dump is approximately 150 feet from and above flood level of the Animas River.

The Pride of the West Mill above Silverton does custom milling of complex ores.(Complex ores are Cu, Zn, Pb, Au, Ag.). The mill capacity is 85 tons per day. The tailings ponds are two to three hundred yards from the river, and there was no visual evidence of stream contamination from the ponds at this inspection.

Durango, Colorado (population 11,500) has four municipal septic tanks and two Imhoff tanks, the effluents of which go directly to the Animas River. The Clover Rich Dairy which processes approximately one thousand (1,000) gallons of milk per day, a garage and offices occupying the same building, have a private septic tank discharging into the Animas River.

Plans and specifications for a complete sewage treatment plant have been received by the State Health Department and U. S. Public Health Service by the City of Durango. It is planned that construction of the plant will begin in 1958. The new installation incorporates the connections of all lines, both municipal and private, which are now discharging into the river.

South and east of Durango the City operates and maintains a sanitary landfill. The operation of the landfill is such that no trash is carried to the river as a result of runoff.

Immediately south of Durango is a small industrial area including a lumber mill and meat packing plant. Each industry has its own sewage or waste disposal system with no direct lines to the river.

Information received from the Vanadium Corporation of America indicates the plant at Durango has individual sewage disposal facilities in the form of septic tanks with one known septic tank effluent line going directly to the river. Undetermined amounts and kinds of trade wastes from the mill are discharged directly to the river. The mill processes approximately four hundred (400) tons

of ore per day. According to the officials of V.C.A., closing the Naturita plant will increase the load to the Durango mill by two or three hundred tons per day.

Thank you.

MR. STEIN: Thank you, Doctor Cleere. Are there any questions or comments from New Mexico?

DOCTOR LELAND: What is the water supply of Durango?

DOCTOR CLEERE: I will ask Mr. Gahr to answer that question.

MR. GAHR: Their supply consists of raw water source from the Florida River where they have an intake. As the population has increased, Durango has been developing another domestic water line to the Florida River and may have to turn to other sources.

The raw water comes to a holding storage reservoir which was created by construction of an earth tank. The town has also constructed a conventional water treatment plant from which water is piped down to the normal type of distribution system. I would like to add that part of the distribution system includes reservoir storage of finished water. Most of these storage facilities are completely closed and covered. One, however, on a hill adjacent to the college down there, is an open earth lined reservoir, and this is scheduled to be replaced sometime in the future. This is the only not-normal type or unconventional unit in the distribution system.

DOCTOR LELAND: This Naturita plant which you speak of -- they contemplate closing it?

MR. GAHR: That is my understanding. We do have some representatives from the Vanadium Corporation of America here in the audience, who could give us more complete data on that.

DOCTOR LELAND: This is the first time we have heard of an expansion of the Durango plant.

MR. STEIN: I would suggest that we wait for their statement.

DOCTOR LELAND: I would appreciate it. That is all I have --, Mr. Caldwell, do you have any comments to make?

MR. CALDWELL: None at this time.

MR. KRAUSE: I note that plans and specifications have been received by the Colorado State Health Department and Public Health Service for a complete sewage treatment plant at Durango. Has the financing for this been arranged; that is, for the construction work?

MR. GAHR: No. The financing does hinge on a Federal grant. It is true the plans and specifications for final construction were received by our office in January, and have gone to Public Health Service. We have approved the eligibility of this plant for Durango. It now awaits the Grant funds which are at this stage not yet appropriated, and we feel that Durango will receive priority as soon as we have knowledge of the appropriation of these funds.

MR. KRAUSE: If they receive them, could they proceed immediately?

MR. GAHR: They have agreed to proceed. They say that construction can start in forty or fifty days after they have received the Grant agreement and have accepted it. It takes time for advertising and letting the contract. They further estimate that the plant will be completed in 450 days, or in other words, it would go into operation about October 1959, I believe.

MR. KRAUSE: The plant at Durango -- is that to be conventional type?

MR. GAHR: The deal under discussion in Durango? -- Well, there is a possibility of asking for a modification to the plans, because of changing the plant location, which will change the way of handling the sewage at the plant.

MR. STEIN: Do you anticipate that the people from Durango will want to make a statement to that?

MR. GAHR: Officially I have not found any of them present in the audience. They might have arrived later.

MR. STEIN: Just to get the record clarified in relation to sources of pollution, - is the packing plant in your opinion a source of pollution of the Animas River at this time?

MR. GAHR: Not at the present. There are several other mining operations or industries which have been in operation or leased at various times in or near Silverton, Colorado, one of which was the Pride of the West Mine.

MR. STEIN: I would like, for the record, to ask if you have any information on the operation of any other mines or mills, as a significant source of pollution at this time.

MR. GAHR: Not at the present time. It is my understanding that they are shut down.

MR. STEIN: Thank you. I think we can go on.

Next on the agenda are statements by the Atomic Energy Commission. As I have indicated, all other participants have been invited by the State agencies, and I might ask New Mexico - have you asked or recognized any of the AEC folks who are here?

DOCTOR LELAND: There are several here from Albuquerque; they probably have their own choice as to who shall speak; and I believe also representatives from Colorado are here.

MR. GAHR: We invited someone from the Grand Junction Office; Mr. McGinley was to come -- from the Raw Materials Division.

MR. STEIN: Is Mr. McGinley here? - Yes.

MR. MCGINLEY: I do not have a prepared statement for the record. The Grand Junction Operations Office would like you to know that we are willing to cooperate to the fullest extent in any surveys or programs of this type.

I would like to be kept informed of the programs or any action recommended, whether by State or Federal agency, in this regard. Other than that, we do not have any prepared statement.

MR. STEIN: Are you speaking for the Raw Materials Division?

MR. MCGINLEY: I am speaking for the Grand Junction Operations Office.

MR. STEIN: (Recognizing Doctor Walker) Would you please identify yourself?

DOCTOR WALKER: I am Doctor Walker, from the Idaho Operations Office. I have most of the mills in the Colorado-Utah area, as most of the uranium mills are assigned to the Idaho Operations Office for inspection. We are a group who merely make inspections of the mills and make recommendations for correction of any violations which may be found. Our recommendations are forwarded to the Division of Licensing and Regulation, who has control over the licensing for compliance with the regulations.

I would like to introduce Mr. Robert Barker, AEC., Division of Licensing and Regulation, Washington, D. C.

MR. BARKER: I would like to say, as a representative, that we also cooperate to the fullest extent with both the State and the Public Health Service in the control of pollution.

MR. STEIN: Thank you. Before Mr. Barker goes on, for the record, I would like to ask the first gentleman who spoke, from Grand Junction, to give his full name. Please identify yourself and your position each time you speak.

MR. MCGINLEY: Frank G. McGinley, Raw Materials Division, Grand Junction Operations Office, Grand Junction, Colorado; and this is Dr. D. I. Walker, Idaho Operations Office, Idaho Falls, Idaho.

MR. BARKER: Robert F. Barker, Division of Licensing and Regulation, Headquarters, Washington, D. C.

I would like to add two things. We are, as you can guess from the title, in the business of licensing and regulating the mills. In this respect, uranium mills fall in this category and are subject to the regulations as issued. In addition, we have recently completed a very sketchy survey of the mills, and this information was made available to the Public Health Service. We, again, would echo the words, that we would like to cooperate, but would like to be kept informed.

MR. STEIN: Is anyone here from the Albuquerque Operations Office? -- Mr. Haycock?

MR. HAYCOCK: Thomas J. Haycock, Albuquerque Operations Office, also in the Division of Inspection.

We are here from Albuquerque primarily for information today, inasmuch as the Durango plant falls under the auspices of the Idaho Operations Office. We are very happy to cooperate with the State agencies, and we hope that Mr. Caldwell and Mr. Jensen will call on us to help, or let us cooperate with them in this work.

MR. STEIN: Thank you. Is there anyone else from AEC who wishes to be recognized at this time? I think I can assure you gentlemen that it is a policy of the Public Health Service to keep the AEC informed of the operations here. I might refer to Doctor Tsivoglou's statement when he asked that the AEC be invited to participate in this study as well as the States; this is something which you and the conferees may wish to consider. I would suggest that we, if the conferees think this is appropriate, in the meantime leave the invitation open so you can check back with home base and discuss it among yourselves. You can, when the findings of the study are being developed, decide what you want to do -- whether or not you want to participate.

Do any of the other conferees have any questions or comments to make on the AEC statements?

MR. GAHR: I would like to ask a question of the AEC representatives. One is, what is the force and effect of the AEC licensing upon the industry? - I mean the mills? What force and effect do regulations have on controlling them in administration of the quality of the effluents they have to discharge?

MR. STEIN: Again, identify yourself for the purpose of the record. I might say this is for all participants each time they speak.

DOCTOR WALKER: Don Walker.

The regulations as of now, which are Title 10, Part 20, "Standards for Protection Against Radiation"; Section 20.103 is the control of effluents released to unrestricted areas, in which category the mill in question, in Durango, would fall. The part and section outlines the amount of radioactive materials by individual isotope which can be released into any area, such as the Animas River, over which the licensee does not have control.

The limits specified for the isotope in question are 5×10^{-11} mc/ml natural uranium, 2.4×10^{-12} mc/ml for radium, and 8×10^{-8} mc/ml for Strontium. Let me say, these are a little bit lower limits than are specified in Handbook 52, for release in unrestricted areas.

MR. GAHR: I would like to ask one more question -- Could you tell us in general terms, what the AEC is now doing in finding out how well licensees comply with your suggestions?

DOCTOR WALKER: Yes, I can. The inspection of the mills was started approximately in the past six months. The first inspection was made in December 1957. There are seventeen operating mills at the moment, with nine under construction throughout the country, the larger of course being in the Colorado-Utah and Grants, New Mexico areas.

It is not a policy of the AEC to go in and make a survey of the licensee. We feel this is a responsibility for administration. What we do, is to see if the licensee is keeping record of the operation, and it will be up to the Commission to then determine whether or not the license is in compliance with the regulations. We do not make the survey. There are times when we make a spot check. It is up to the licensee to furnish the results that the Commission has requested with regard to compliance.

MR. GAHR: Is that information available to other agencies? Would it be available to the Colorado State Department of Public Health?

DOCTOR WALKER: Whenever we can, out on these inspections, we not only invite the State Health Departments, but encourage them to make the inspections. The results which we have obtained go to the licensee as well. These are considered for AEC internal use for control of license material for licensees. However, I see no reason why in Colorado you could not have access to these records.

DOCTOR CLEERE: I want to introduce Mr. Jack Torrey, Industrial Hygienist, Colorado Department of Public Health. If it is agreeable, I would like for him to participate in the discussions.

MR. TORREY: I have a question, more in the nature of a statement. It is my understanding that inspections in Colorado of the mills and processing plants have been conducted jointly by AEC representatives and the State Department of Public Health, which we think is an excellent working relationship between AEC and the State Department of Public Health. A question please? -- If during a joint inspection by the AEC and the State Department of Public Health, there are definite violations detected in a given plant, then which agency is responsible for enforcement of standards and regulations?

DOCTOR WALKER: I think this is pretty clear cut. We are strictly a fact-gathering group. Our results are forwarded to the Division of Licensing and Regulation, the organization which has the enforcing power. We do not have the power for enforcing the regulations.

MR. BARKER: Barker, AEC, Washington.

Perhaps I can speak a little more directly as to force and effect. The AEC Act, established certain requirements for the process and use of certified materials in the Act. Included in these definitions was source material, which is uranium and thorium. The uranium, which is processed in the mills under discussion, at least most of the mills, are included in this definition of source material, and therefore are subject to the licensing control of the AEC.

This control is effective to give a regulatory program which involves two, I should say three, phases. (1) Simply desiring license issuance; (2) The license is based on an application in which information is given regarding the proposed use, the description of safety precautions and definition of the control of the material. The license is issued for processing the raw uranium ores and use of the refined material through processing and milling. It is then the inspection function which reviews the operation in the mills with regard to their compliance with the regulations.

Third phase; the Production Division has regulations which set forth the standards to which Mr. Walker referred. This is our purpose. Here is a Federal Register -- if you would like, I can submit this copy of Part 20 as part of the record.

MR. STEIN: Yes, thank you.

(FEDERAL REGISTER, Title 10, Part 20, entered as EXHIBIT "A")

MR. BARKER: The follow-up would be, as far as total compliance is based on, much the same procedure as a conference. A legal procedure which has been established is Part 20, of Title 10, "Standards for Protection Against Radiation". The licensee is notified of the alleged violations, and is given a period of time in which to comply; that is, to correct the deficiency. If the corrections are satisfactory, then there is no further discussion or no further need for action. If the corrections are not made, and a hearing is called, and I am short-cutting a little bit here; but I think it is sufficient to indicate that everyone is given sufficient opportunity to present their views in regard to continuance of the license or the correction of the deficiencies which have been found under the license. If these are satisfactorily resolved the licensee is permitted to continue. Otherwise, the license will be revoked or amended, as necessary, to enforce compliance with the published regulation. The effect, then would be the removal of the license, if necessary, which would not permit processing of the raw ore.

DOCTOR CLEERE: After a plant manager is notified of violations by the AEC, is it then the responsibility of the AEC to render consultation service to the industry involved in an effort to assist the industry in complying with the AEC Standards and Regulations, or do you consider that a responsibility, in Colorado, say, of the State Department of Public Health?

MR. BARKER: I will not side-step this, but I would rather suggest the position of the AEC in that they are quite willing to explain, as may be necessary, the intent of the regulations. Again, as a regulatory agency, it is necessary that they not be in a position of suggesting the exact method that one will use in complying with the regulations. If one were to do that, it would then be a position of inspecting against his own suggestion. For this reason, we suggest the intent of the regulations, the deficiencies as we understand them, attempt to clarify them as much as possible; and again not provide services for the licensee which are available commercially or from State groups such as you, or Public Health Service. We realize they all depend on you primarily.

MR. STEIN: May I clarify one point here? We are not in the business of competing with consulting engineers. We are a regulatory agency, for the purpose of letting the appropriate engineering firms come up with the solutions, rather than the regulatory agency providing such services.

DOCTOR CLEERE: As a State agency, I have qualified personnel to render the consultation services referred to. Therefore, it would be desirable to call on the State agency to render that type of consultation service to the industry involved in the violation of standards and regulations.

DOCTOR WALKER: The responsibility for compliance of the matter lies wholly with the licensee. If they can obtain this from the State Health Department it will be acceptable by us. On the other hand, if they obtain the service from any private concern, the responsibility lies wholly with the licensee to obtain the information contained in the regulation. We are quite satisfied - we are not trying to impose, therefore on the State Health Department. Again, we point out, it is the responsibility of the licensee to obtain this information to comply with the regulations.

DOCTOR CLEERE: Thank you. That clarifies the question. At this time I would like to call on Mr. Torre.

MR. TORREY: J. D. Torrey, Colorado Department of Health.

I would like to ask Doctor Walker to clarify his figures that he gave. I think you gave the ones for air -- would you like to give the ones for water?

DOCTOR WALKER: I did quote the figures for air; the water figures I did not quote. They are in the Table of Title 10, Part 20.

MR. STEIN: Do we have any comments or questions from New Mexico?

DOCTOR LELAND: A question which I think should go in the record -- Must a licensee comply with existing State regulations having to do with water pollution?

DOCTOR WALKER: We have certain regulations which are imposed on the licensee by Federal regulation. There is nothing in the regulations which precludes a State from putting more restrictive measures on a licensee if it should desire. It is doubtful that a State would put on less restrictive measures. There is nothing to prevent a State agency from putting on more restrictive regulations.

DOCTOR LELAND: In that case, consider a State Department making a certain survey, feeling that their regulations were violated; would the course of appeal be through AEC?

DOCTOR WALKER: If the licensee were in agreement with the AEC regulations, it would then become strictly a State problem.

DOCTOR LELAND: In the case of a complaint by a State, wherein, perhaps they feel that even two regulations were violated - would the course of action be through AEC or direct to the licensee?

DOCTOR WALKER: We would feel slightly embarrassed if the State found that what we had approved as being O.K., was not in compliance with State regulations. We would do the utmost to get the licensee in compliance, as so written.

DOCTOR LELAND: We have at least three experiences with the Colorado State Health Department in testing this particular situation. Do you have more data? You have conducted a series of tests around this Durango mill.

DOCTOR WALKER: A series of tests - mostly spot checks. The New York Health Department Safety Laboratory has conducted some preliminary surveys. The results of these surveys were obtained from mine mills. The intent of the survey made by the Health and Safety Laboratory of New York was not connected in any way with the inspection program. The Division of Biology and Medicine attempted to obtain data which would give them a background of hazards relative to the uranium industry; not only milling, but processing and similar situations. The information which they obtained from the mills will not be used against the licensee for compliance with the regulations. This point should be made clear to Mr. Brinker.

DOCTOR LELAND: Such data, however, could perhaps be made available if desired on this survey, for survey purposes alone.

DOCTOR WALKER: The information as obtained by the Division of Biology and Medicine has been turned over to the Division of Raw Materials for use as they see fit. The information will be compiled into a composite report, of all the mills which were surveyed, and which may be surveyed in the future, giving the ranges not only of the air tolerances, but the water as well, for each of the various processes throughout the milling industry. Most of the survey thus far has been concerned primarily with the concentrations of air-borne activity within the mill, some of course has been done with the effluents of the mill.

MR. BARKER: In direct answer to your question, the information which we had obtained was directed to the Public Health Service. Doctor Tsivoglou was call in and looked over the data. Because of its spot sampling nature, the particular item under which this survey was conducted was to determine environmental problems primarily, rather than in-plant conditions. Doctor Tsivoglou felt that this information was not necessarily sufficient to add much to his previous data, so he had not included it.

MR. CALDWELL: This material that has just been mentioned is really in the nature of research. Going back to the original statements, as I understand the working of AEC, does the licensing division of AEC really expect the industry to police itself and keep records which would show that they are in accord with the regulations?

MR. BARKER: Yes, that is about it.

MR. STEIN: May I ask the AEC representatives a question? According to the regulations, is the Animas River an unrestricted area?

DOCTOR WALKER: According to the area over which the licensee has no control, not including the interior of the plant and facilities; therefore the limits in this particular case are considerably restricted.

MR. STEIN: As I understand the physical limits of the plant at Durango, the Animas River is outside the area.

DOCTOR WALKER: That is correct.

MR. STEIN: We have obtained a copy of the license issued to the Vanadium Corporation of America, R-102, issued in November, 1957. It says this license expires December 1, 1958, and is subject to all the provisions of the AEC Act of 1954, and all valid rules and regulations relative to isotopes. Is this license still in force and effect?

DOCTOR WALKER: Yes. Most of these source material licenses are issued on a one-year basis. However, most of the mills which are contracting for uranium, have contracts with the Division of Raw Materials, and most of these contracts are in effect until 1962. Some of the newer licenses, when they have been re-issued or renewed, their expiration date has been made to correspond with the contract, - in this case 1962.

MR. STEIN: Is the statement that the expiration date will be extended to the contract date, correct?

MR. MCGINLEY: That is correct.

MR. STEIN: Can we assume that you did not consider the license to be in violation of the regulations since the license is in force?

DOCTOR WALKER: What do you mean by license --

MR. STEIN: If the license were in violation of the regulations as prescribed, the license under your regulation, there presumably would be some sort of action for corrective measures or something to remove the license, since this license is in full force and effect. -

DOCTOR WALKER: I am not speaking of the Durango mill, but of all mills. No mill has as yet been in compliance with the regulations inasmuch as these place the responsibility on the licensee to determine the various limits, for not only air-borne activity radiation levels but effluents released to unrestricted areas. Most of the companies only keep the limits of their effluents discharged. We have cited them, however, for failing to determine the concentration of radioactive material in the effluents released in the unrestricted areas.

MR. STEIN: This citation has not resulted in removal of the license? -

DOCTOR WALKER: No. --

MR. STEIN: What is the procedure if a mill is cited for not being in compliance?

MR. BARKER: Conferences usually can be resolved in a relatively short period of time; other actions of a regulatory nature frequently require a longer period of time. This is the case with the mills. The initial inspections were made slightly less than six months ago. The follow-up action which I very briefly sketched to you before, usually has had to be fully taken care of through conferences and correspondence. Therefore, perhaps we are jumping the gun, so to speak, to say that an actual citation has been made, because in Washington the piece of paper has not gone to the licensee yet. When this is done there will still be a period of time during which the conference table, this time by correspondence, will be participated in by the Division and the licensee. The consultation on the action cites the responsibility of the licensee, the action which is indicated. Any follow-up inspection which will probably be necessary, in this case since there was not data from a survey to examine from a first inspection, will take a period of time. I might suggest as to the period of time necessary; it looks like it might coincide with the survey that is being directed today. Therefore, removal of this license will probably depend in part on the licensee's action with regard to his initial letter, which he will write.

MR. STEIN: May I ask one final question? I understand that by December 1, 1958, the licensee may be in position to get a license for the duration of his contract; that is, over a period of three or four years, until 1962, without a determination being made on anyone's part that the licensee is in fact in complinance with the terms of the license.

MR. BARKER: The compliance with the regulations is a condition for renewal; his license can be revoked at any time that he is determined to be in non-compliance. The mechanism is established for taking necessary action to either revoke, suspend or amend that existing license, if that is indicated. Therefore, if the wheels of this conference to which I referred, were so slow as to result in a renewal of this license prior to the time a determination

could be made of his compliance or non-compliance; it would then be possible at any time to revoke his license prior to the expiration date, which would be shorter than the four years. It is possible to take such action as might be necessary through the mechanism of amending or suspending the license. That is the way that we have of operating.

MR. STEIN: Thank you. Are there any more comments?

I would like to thank the representatives from the AEC for a very illuminating discussion of the problem. If I might comment now, I think you will recognize that both the AEC and Public Health Service have statutory responsibilities in this, and that our objectives are similar; and as this develops we could work together jointly in a reasonable way to carry out the responsibilities we have and the ones you have. I think the objectives are about the same.

For the record, I might point out that due to the responsibility we have under the law we are required to institute proceedings such as this, to arrive at an understanding of the problem and a method of procedure; in this case, radioactive waste discharges originating in Colorado which may endanger health and welfare of persons in New Mexico.

At the present time we would like to call upon the other participants. We would like to call on the Colorado conferees to introduce the folks they have invited. I shall ask the participatns to get up and identify themselves, and if they have a statement, to come forward. There are two alternatives for the participants: If you do not have a loud voice you may wish to sit here (indicating chair by microphone); if you feel that your voice can carry to the microphone, you may speak from where you are.

Doctor Cleer, or Mr. Gahr, would you call on your participants?

MR. GAHR: The Colorado Department of Public Health, formally, by letter, notified these participants, which I shall read, and later will call on those who have asked to be heard.

First, Mr. John B. Barnard, Jr., Attorney General's Office.

MR. BARNARD: Mr. Gahr, as you say, I am from the Attorney General's Office, currently working on the matters in question. I am here as an observer and have no statement.

MR. GAHR: Mr. Richard L. Moore, Colorado Game and Fish Department. Do you have a statement at this time?

MR. MOORE: Yes.

MR. GAHR: Will you come forward, please?

MR. MOORE: I have a statement representing the feelings of the Colorado State Game and Fish Department at this time.

At present, the Animas River is a poor trout stream. Mineral pollution is the greatest detriment to its trout environment. There are two main sources of the pollution. One, the old mines and mills in the Silverton

area, most of which are not operating, but continue to contribute to the poor water quality by erosion of mine and mill wastes. Two, the VCA uranium mill in Durango has virtually destroyed the trout habitat in the Animas River below that point by discharging mill wastes into the river.

The effects of these conditions in the Silverton area are insidious and sporadic. Historically, trout have never existed in North Mineral or Cement Creeks because of natural pollution of their waters from draining highly mineralized areas. The same is true of several small creeks above Eureka, an old mining camp above Silverton on the mainstem of the Animas.

Add to this the tailings washed into the river by rains and runoff from old mill operations which have been out of business for many years. Further, add more tailings which enter the river, either deliberately or accidentally, from mills still operating, at least intermittently in recent years -- it all adds to a very marginal trout habitat, lessened somewhat by dilution from each good stream coming into the Animas Canyon below Silverton. In other words, the water quality for trout improves slowly all the way to Durango. The majority of the trout are planted from Durango to Bakers Bridge, a short distance below the mouth of the Animas Canyon. A few trout are hauled into the lower miles of the canyon -- the upper portion of this railroad plant being discontinued in 1956 due to the poor water quality and resultant low fishing pressure. We do not anticipate more than a fair return to the creel of trout planted in the lower end of the canyon for the same reasons. Therefore, the section from the mouth of the canyon down to near the New Mexico line represents the most valuable part of the river from the trout fisheries standpoint.

However, approximately one-half this distance, beginning at Durango, has been largely destroyed by pollution coming from the VCA mill at Durango. Here, it is evident that the uranium mill is the major contributor of toxic wastes -- there are no other mines, mills, or naturally polluted areas that add significantly to the pollution below Durango, as was the case on the headwaters near Silverton.

In summary, there appears that nothing can be done to stop drainage of toxic substances from some of the smaller streams on the headwaters of the Animas River. Likewise, little or nothing seems practical to stop the same substances washing into the river from mine and mill dumps which abandoned operations long ago. On the other hand, any mill now active should not be allowed to further contaminate the river because there is contamination already present. Most important of all, the VCA should be forced to properly dispose of their wastes so that no toxic wastes enter the river. There are no State laws under which the Colorado Game and Fish Department operates that effectively cope with such stream pollution as now exists in the Animas River.

MR. STEIN: Do the New Mexico representatives have any questions?

DOCTOR LELAND: No questions.

MR. STEIN: Thank you very much.

MR. GAHR: Mr. Moore, I believe it was the import of this statement that the damage to trout was caused mainly or essentially by finely divided material coming from mine dumps and mills. Is that correct?

MR. MOORE: That is our belief. I might add that the Game and Fish Department has no long-range studies to support this situation. It is the situation as it exists.

MR. GAHR: I would like to call on Mr. McGinley, representing the Raw Materials Division, Grand Junction Operations Office.

MR. MCGINLEY: Thank you, Mr. Gahr. I believe that the AEC position in this matter has been adequately covered by those that preceded me.

MR. GAHR: I would like to call on any representative of the Durango Chamber of Commerce who may be present at this time. Is anyone present?

Is there anyone here representing the Durango city government? - Is there anyone representing the Silverton city government? - Is there any representative here from the San Juan Basin Health Department out of Durango?

We should like to call, then, upon Mr. John A. Maxwell, representing the Vanadium Corporation of America at Durango. They have a paper they would like to present. Would you come forward at this time?

MR. MAXWELL: I would like to introduce Mr. Fred A. Brinker of the Vanadium Corporation of America at this time.

This is a statement by the Vanadium Corporation of America, Durango, Colorado, for the U. S. Public Health Service conference in Santa Fe, April 29, 1958.

The company operates a vanadium - uranium processing plant at a millsite on the west side of the Animas River, just south of the city limits of Durango. This mill has been in continuous operation since 1948.

In the disposal of the various waste products from the mill, the company has recognized the importance of these waste products as related to pollution of both air and river. It has been diligent in its effort to comply with the laws and regulations relating to pollution.

In this work the company has had the cooperation of the local, state and federal agencies; and in the future will work with these agencies on any reasonable program for improvement of conditions relating to pollution.

Since 1956 all roaster gases have been treated by scrubbing and air pollution from this source is practically eliminated.

It has been the policy of the company from the start of its operation in Durango to impound the solid tailings produced. The coarser fraction of this tailing, which is about 95 percent of the total tailing, is no problem. The slime fraction is a problem and requires special handling to prevent its discharge into the river. During the last year a flocculent has been used in the mill which aids in the settling of this sline fraction.

In addition to the overflow from the tailings pond there is a liquid waste overflow from the plant. This contains some sulfates, chlorides, and small amounts of vanadium and uranium. At present this overflow contains an alkaline waste product in such amounts that the pH of the total overflow is alkaline.

A change in our processing procedure is to be made about July 1st that will change the composition of this liquid waste product some.

Quoting from "Report of Survey of Contamination of Surface Waters by Uranium Processing Plants, September, 1955", by Tsivoglou, Bartsch, Holaday, and Rushing:

"Uranium Ore Processing. Upon being received at a typical mill, the ore is processed for recovery of uranium and vanadium. Processing steps differ in detail at different mills, but in general involve crushing and grinding the ore, roasting, and leaching. The liquor is then subjected to heat and pH adjustment for separation of the uranium through precipitation of uranium salts, which are pressed to form "yellow cake". The vanadium salts are then precipitated as "red cake" by further pH adjustment of the filtrate from the separation process. The filtrate is then discarded. The "yellow cake" is fused to form "black cake", which is then crushed and washed. The sand is discarded as tailings, and the filtrate (which still contains some vanadium) is returned to the mill process. Sources of radioactive waste at a typical mill may include wash waters, the filtrate following precipitation of vanadium, sands and waste solids. Some part or all of the waste products may be stored indefinitely in a tailings pond pending possible future recovery of other minerals, but in one case where there was no tailings pond (see below) all wastes were discarded directly to a nearby stream. Where a tailings pond is used, it is usually located at the stream's edge, and wastes to the stream include leachings from the tailings pond as well as certain direct discharges such as process wash waters.

"Previous Studies. Prior to the 1955 field survey several small sets of samples were collected and analyzed. Eight river water samples collected from Colorado streams in October, 1950, by the Western Gulf and Colorado Basin Office of the Public Health Service, were shipped to the University of Rochester and there analyzed for dissolved radium by Hursh. (1) The results were as follows:

TABLE I

Water samples of October 1950

Location	River	Flow, cfs.	Soluble Radium, uuc/l	
			Above Mill	Below Mill
Durango	Animas	300	0.20	4.5
Naturita	San Miguel	64	0.13	16.9
Uravan	San Miguel	64	4.4	43.4
Rifle	Colorado	1600	0.36	4.5

Also quoting from the same report:

"The 1955 Field Survey. During the period September 22 through 30, streams in the vicinity of eight of the operating ore processing mills were visited for purposes of making a general sanitary and biological survey, and to collect samples for subsequent radioassay. The mill at Grants, New Mexico, was not visited. Two of the processing plants - those at Rifle and Durango, Colorado - were visited and the process observed.

"Stream sampling stations were generally located immediately above and at a selected point below each of the mills. At each such station grab

samples of water, river mud, and aquatic organisms were collected, except where circumstances prevented. Biological samples included both algae or other plant growth attached to rocks, where available, and bottom animals (developmental stages of caddis flies, stone flies, and mayflies, etc.).

"A general description of each of the streams surveyed, as of September, 1955, is as follows:

"Animas River near Durango, Colorado

About one-half mile above the uranium mill this stream was in good condition, about 3 to 4 feet deep, with coarse rubble and small boulders, scarce to moderate algae and bottom animals. At a location about a half mile below the ore processing plant the river appeared unchanged in character.

The waste products from the acid leach process were delivered to a tailings pond. Other mill wastes were discharged directly to the Animas."

Table II

Radioactivity of River Waters

River	Location	Radioactivity, uuc/l			
		Gross* Alpha	Gross* Beta	Soluble Radium	Soluble Uranium
Animas	Above Durango	2	32	0.2	0.3
Animas	Below Durango	34	26	3.3	8.0
Colorado	Above Rifle	0	7	0.4	n.d.
Colorado	Below Rifle	49	15	0.4	n.d.
Colorado	Above Grand Junction	13	22	0.3	n.d.
Colorado	Below Grand Junction	183	295	39	n.d.
San Miguel	Above Naturita	10	16	0.3	2.8
San Miguel	Below Naturita	148	61	9.4	24
San Miguel	Above Uravan	92	46	4.9	21
San Miguel	Below Uravan (1)	4,700	5,490	86	n.d.
San Juan	Above Shiprock (2)	220	369	0.2	n.d.
San Juan	Below Shiprock (2)	170	204	0.3	n.d.
Jordan	Above Mill	5	28	0.4	n.d.
Jordan	Below Mill	23	51	n.d.	n.d.
Creek	Above Monticello	33	67	0.3	n.d.

* Total of suspended and dissolved fractions

** Minima

(1) Alpha activity about 50 percent dissolved; beta activity about 12 percent dissolved.

(2) Suspended solids very high (3150 and 4400 PPM); most of gross alpha and beta activity in suspended form.

Table III

Quality of Mill Effluents

River	Location	Radioactivity, uuc/l. Gross* Alpha	Gross* Beta	Soluble Radium	Soluble Vanadium mg/l.
Animas	Durango, tailings pond effluent	3,220 (2)	7,510 (2)	25	13.5
Animas	Durango, direct effluent	43,200	16,300 (2)	76	62
Colorado	Rifle	1,150	1,100	4.5	1.5
Colorado	Grand Junction	6,930 (2)	9,210 (2)	920	3.7
San Miguel	Naturita	710	590	5.4	4.3
San Miguel	Uravan	244,000 (1)	305,000 (1)	83	6.9
Jordan	Salt Lake City	72	140	5.5	1.4
Creek	Monticello	33,700 (2)	31,400 (2)	81	355

* Total of suspended and dissolved fractions.
(1) Virgually all suspended activity.
(2) Mainly dissolved activity.

"In this connection, it is also worthy of note that in its proposed rules (8) the Atomic Energy Commission suggests a maximum permissible average concentration (nonoccupational) of radium in water of 4.0 uuc/l.

"Soluble uranium at polluted locations was of no consequence, since the MPC for natural uranium based on its chemical toxicity, is 70,000 uuc/l."

Further work was done in 1956 and is reported in "Effects of Uranium Ore Refining Wastes on Receiving Waters", by Tsivoglou, Bartsch, Rushing, and Holaday, presented at the 4th Nuclear Emergency and Science Conference, March 17-21, 1958; but this work did not include sampling of the Animas River.

Quoting the above report, Page 3, "The maximum permissible concentration in a domestic water supply is 40 micromicrograms per liter." This permissible water concentration refers to soluble radium, and Handbook 52 further advises that a safety factor of 10 be used with the above figures.

At present, work is in progress in cooperation with State and U. S. agencies, but all the results are not available at this time.

On the basis of present operation the following is the maximum volume of liquids discharged into Animas River:

Direct discharge	125 gals per minute
Tailings Pond Discharge	175 gals per minute
Total	300 gals per minute

The average flow in the Animas River at Durango is:

1,130 cu. ft. per second
507,178 gals per minute

The average dilution then becomes: 507,178 to 300
1,691 to 1

On April 17, 1958, the company took the following samples at regular intervals over a 24-hour period:

#1 Animas River above mill
#2 Animas River at Sunnyside Bridge about 10 miles below mill
#3 Direct discharge into river
#4 Tailings pond discharge into river

Samples #1 and #2 were sent to Department of Public Health, State of Colorado, for analysis in addition to company analysis.

Animas River Flow at Durango, April 17, 1958:

800 cu. ft. second
359,064 gals. per minute
Dilution rate 359,064 to 300
Dilution rate 1,197 to 1

Lightner Creek enters the Animas River below flow measuring point so Sample #2 below mill has the lightner Creek volume in addition to measured flow. Also, the City of Durango sewage plant discharge enters river below the mill and above #2 sample point.

The above samples were analyzed in the company laboratory with the following results:

	pH	V_2O_5	U_3O_8	SO_4	Cl
#1 River above	7.60	nil	trace	.0741	.0139
#2 River below	7.95	.0002	.0004	.0801	.0114
#3 Direct discharge	8.75	.1630	.0520	21.81	8.70
#4 Tailings pond discharge	2.30	.251	.0880	5.48	1.10
#5 Composite #3 and #4	4.10	.214	.0730	12.28	4.26

All of the above results are in grams per liter. To convert to parts per million multiply by 1000.

Although the vanadium content in the river checks closely with the calculated content from addition and dilution, the chloride content is less down river than up river.

The analysis has been checked and this difference indicates an unbalance in some of the soluble contents of the river water.

We wish to add in closing this statement that the Vanadium Corporation will work with the various agencies on this matter and will consider any suggestions given for their possible application to the problem.

Supplemental Report: Recent radiation studies made by Vanadium Corporation of America in connection with Colorado Health Service on the Animas River:

Date	Location	Flow cfs.	Effluent to River Flow Ratio	Soluble Radium uuc/l Above Mill	Below Mill
3/24/58	Animas	400	1-600	5.0	6.0
4/17/58	Animas	800	1-1197	2.4	5.0

The above analysis was made by Colorado Health Service at their laboratories under the direct supervision of Mr. Jack Torrey.

That is our statement.

MR. STEIN: Thank you, Mr. Maxwell. I would like to suggest that we put your statement on the record at this point.

Are there any questions from Colorado?

MR. GAHR: Is that information available to any of us?

MR. MAXWELL: That is Company confidence.

MR. STEIN: Are there any further questions? - New Mexico?

MR. CALDWELL: I have one question. We made a joint inspection of the mill. At that time it was our understanding that the tailings pond area is limited. Is there any planning on the part of the company in terms of new storage at this mill site? The plans, as I understand it, call for a considerable increase in production, or at least more than has been the case in the past.

MR. MAXWELL: That is right.

MR. CALDWELL: Thanks.

MR. STEIN: Are there any further questions from New Mexico?

In reference to the question Doctor Leland brought up before -- do you care to comment on the statement that we have heard that the Naturita plant will be closed?

MR. MAXWELL: We have closed the Naturita plant on September 1 of last year. We will expand our Durango operation from 450 tons per day to 700 or 750. We have recently doubled the size of our tailings pond and have secured sixty additional acres downstream for tailings disposal. I think we are adequate in that respect.

MR. STEIN: May I ask one more question? As I read the AEC license, you can expand that operation and still be covered by that license?

DOCTOR WALKER: The license as issued by the Commission, states uranium processing - without limitation as to quantity.

MR. REYNOLDS. S. E. Reynolds, New Mexico State Engineer. I wonder if you made computations of the dilution ratio at minimum flows?

MR. MAXWELL: I have not. No.

MR. REYNOLDS: Would you know what the minimum flow is?

MR. MAXWELL: I might ask Mr. Brinker.

MR. BRINKER: The minimum flow in the winter is around 200 cfs, as compared with the April figure that we have in the statement of 800 cfs.

MR. REYNOLDS: Would you know the minimum flow in August?

MR. BRINKER: No, I don't.

MR. STEIN: Mr. Reynolds, I would like to thank you for your contribution.

DOCTOR TSIVOGLOU: About stream gauging stations, -- records for Durango, Cedar Hill, New Mexico and Farmington, New Mexico show minimum daily flows at these stations have been recorded at 94, 90, and 5.4 cfs., respectively.

MR. STEIN: I might indicate for the folks in the audience who might not be familiar with the water pollution control problems, that this water pollution control is somewhat similar to a utility, such as a telephone utility or an electric utility. In an electric utility they build for peak loads. If you can just reverse that, water pollution control is designed for minimum low flows because, generally speaking, when there is a minimum amount of water for dilution in the stream that is where you get critical conditions. The engineers have made long surveys and checks. Obviously they do not design for minimum flows for a stream which might occur every fifty or one hundred years. We could anticipate a minimum flow for a certain period of time, for perhaps each five years, the criteria may be designed for the critical periods.

Thank you, Mr. Maxwell.

Are there any further questions?

MR. GAHR: Mr. Chairman, we have in the audience Mr. W. L. Bruce, Secretary-Treasurer of the Animas River Water Users, of Durango. Prior to his coming forward, I would like to present the Chairman with some photographs, together with his prepared statement.

MR. STEIN: If there is no objection from the conferees we will put them, for the record, in the files in Washington.

MR. BRUCE: W. L. Bruce, Secretary of the Animas River Water Users Association.

I might say that we are in the position of a stepchild in the water pollution problem. This organization was started in 1951, but after discussions of the pollution of the river at the meetings of the Animas River Grange 194, situated at Hermosa, Colorado, the Grange masters appointed a committee to work on pollution problems. In our investigation and compiling of data, we consulted some attorneys about what action we should take, and they advised us to incorporate as an organization to handle this situation.

The Animas River Water Users, Inc., sponsored by Animas Valley Grange 194, was organized August 15, 1952 for the purpose of preventing the Silverton

mines from dumping mine tailings into the Animas River and also for stopping the use of Animas River for sewerage and garbage disposal, so that Animas Valley residents could have clean water for irrigation and domestic purposes.

In addition to the benefits of Animas Valley residents having clean water for domestic use from the Animas River, it is our desire to make the River an asset to Durango and the San Juan Basin, as an attraction for sportsmen and tourists, for fishing and outdoor mountain recreation.

In our investigation of Animas River sources of pollution, this is what we found:

On account of the small amount of mining around Silverton for several years, there has been very little pollution from mine tailings. But for the past 35 or 40 years, the Town of Silverton has been using a flat piece of ground on the bank of the Animas River as a city dump, and the raw sewerage from the town has been emptying into South Mineral Creek since the sewer system was installed. South Mineral Creek connects with the Animas River a short distance from where the mouth of the sewer is.

Every conceivable kind of garbage has been found in the city dump from household refuse to carcasses of dogs, cats, deer, elk and butcher shop, hotel and restaurant meat scraps. The city takes a bulldozer and pushes this garbage to the bank and into the Animas River to be washed away and finally destroyed by decomposition. The same condition exists at Durango as regards sewerage disposal. It is common practice for all residents and businesses along the Animas River at Durango to dump their garbage and refuse into the river -- which our pictures will substantiate.

There are six outlets of open sewer emptying into the Animas River and the present Imhoff tanks are so heavily loaded that practically raw sewerage goes through them and into the Animas River.

Refuse from the Vanadium Plant at Durango is being dumped into the River. This has been a bitter contention of sportsmen in that it pollutes the stream and is injurious to fish in the river which river has for years been attractive to fishermen and tourists in Durango.

We are presenting pictures to substantiate our contention of Animas River stream pollution by the accumulation and dumping of garbage and sewerage along the banks and into the river at Silverton and Durango and residents between these towns using the river for a garbage dump ground.

The town of Durango is now in the process of putting in adequate sewerage plant to handle all city sewerage and stop it from going into the river.

We have had a number of meetings with Silverton City officials in an effort to have the garbage kept out of the river and a treating plant for sewerage.

On July 16, 1954, a delegation of fourteen Animas Valley residents had lunch with the Mayor and some of the City Councilmen. The garbage and the sewerage was thoroughly discussed. It was promised that the garbage would be bulldozed back from the river and a new dump ground would be found; but that the

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town was so badly in debt that it would be impossible to finance a sewerage treating plant. Later inspection showed that the garbage had been pushed back from the river. But on October 31, 1955, two residents of the Animas Valley, with their families, were in Silverton and on examination of the dump, they found a Silverton city employee pushing all the garbage up to the bank and into the river.

They contacted the Mayor and on inquiry as to why this was being done, were told that the town had been informed by La Plata County Health Unit that the garbage would not contaminate the water and make it unsafe for domestic use.

From that time on we have not been able to get any satisfactory solution of the stream pollution at Silverton. We have not been able to get any help from the State or San Juan Basin Health Units in our efforts to stop pollution of the Animas River.

Quoting from a letter from Dr. Cleere dated July 13, 1954, "Regarding the situation at Silverton -- There is ample water available for dilution of sewerage at Silverton". And the distance to places of domestic consumption would tend to purify the water and not create a health menace.

After checking the carcasses from the dump that are bulldozed into the river and the sewerage that comes from the sewer outlet, it is our contention that the animal carcasses do not disintegrate very quickly. Every time you take a drink of water, the thought comes up that you may be drinking somebodys unborn child.

The financial situation in Silverton has changed. All mining property which was not paying taxes has been sold and this is now back on the tax rolls, and the Town of Silverton and San Juan County are now in good financial condition and there is no reason why they should not be forced to provide healthful sewerage and garbage disposal.

We think discrimination is being shown by both the State and local Health Units. If an individual in the community builds a home and installs sewerage, he is not allowed to have his disposal field closer than fifty (50) feet to an irrigation ditch or stream. His plumbing is inspected and the installation must comply with State Health specification, which is fine. But we do not see where a town, community or an industry should not have the same treatment in sewerage or garbage disposal. -- Respectfully submitted, E. R. DeLuche, President, Animas River Water Users Association.

Now, I have two letters from residents of Durango that I would like to incorporate in this report. One is from Ross D. McCausland, owner of the "Ah Wilderness Guest Ranch, Inc." on the Animas River 23 miles north of Durango.

"Trout fishing in the Animas River between Rockwood and Elk Park, a distance of about 21 miles is usually very good. Occasionally very stagnant water is pumped into the river out of mine shafts in the Silverton area as well as mill tailings. This makes the water so murky and highly acid that the fish do not bite and of course fly fishing is out of the question. In the past four years this condition has occurred on the average of four to five times during the summer. Previous to that time when the mines and mills in Silverton were more active the condition would exist for several weeks at a time.

"The Animas River to the south of Durango appears to be excellent water for trout fishing. However, this appearance is deceiving. There is a terrible stench from the putrid water and a thick slime covers the entire floor of the river for at least ten miles below Durango. Besides this repugnant condition of the water and the river bed one who is persistant in trying out the fishing will likely have the water turn murkey in just a few minutes from waste material dumped into the river from the V.C.A. ore processing plant at the south end of Durango. This section of the river could be a very attractive fishing spot for local people and tourists but it is not because of the condition described above. It is apparent that much sewage goes directly into the river both above Durango and within the city limits. A great many trash and garbage dumps are seen along the banks where high water partly washes them downstream.

"The city dump at Silverton is pushed into the Animas River as it is a convenient means of disposing of the city refuse. All along the river one sees tires, cans, discarded clothing and other refuse that has washed downstream from this Silverton dump. Also one can observe the direct entrance of the city sewage system into the Animas River about a half mile below Silverton.

"The Animas River has many miles of open water that would provide excellent fishing for the sportsmen but the above conditions take away most all the appeal and kill a great many of the fish in the river." -- Ross D. McCausland, Owner and Manager of "Ah Wilderness Guest Ranch, Inc.," on the Animas River 23 miles north of Durango.

I also have another letter from a citizen of Durango, as to a condition that happened on the 5th of April --

"This is to certify that on April 5, 1958, Roy Magganell, 1015 Grand Ave., Albuquerque, New Mexico, John J. Cobb, and myself (Elvin T. Cobb), 1061 Fifth Ave., Durango, Colorado, were fishing from the railroad bridge crossing the Animas River to the Stockyards opposite the VCA smelter. At about 9:30 o'clock A.M. a stream of red, brackish water began to pour forth from the smelter which gave the stream a color similar to what we have during our high water period. I might add that this was not an isolated instance when the stream is discolored from water from the smelter, as I have seen the same condition time and again while hunting ducks downstream from the smelter.

"I have driven over one of the two highway bridges upstream from the smelter and when crossing the bridge noted how clear it was. At times one can see fish in the water. Then I have driven on the same day across the bridge in Mexican flats downstream from the smelter to find the water muddy from tailings from the V.C.A. smelter.

"I have hunted and fished the Animas from Bondad to Durango and scattered along the banks of the stream are metal drums which have been pushed over the dump at the smelter and have been scattered downstream by the high water.

"It is my observation that the condition has become progressively worse during the past five years. Some five years ago very fine fly fishing was possible downstream from Durango. Today fly fishing downstream from Durango is practically nil. In fact all the fish were killed for a distance of five miles downstream from Durango about two years ago by acid which was dumped into the river because of an accident at the smelter. The Fish and Game Department reported the fish killed.

"Nor is the V.C.A. smelter the only polluter in Durango. It is my understanding that garages do not have traps to catch their oil, etc., and this is drained into the river at times. It is my understanding that traps should be used to catch the refuse in such places as garages.

"The City of Durango has only partial sewerage disposal. At most they only take out the solids. I believe there is one or two sewers that dump raw sewerage into the stream.

"My interest in this is that of a fisherman, hunter, citizen and taxpayer in this community. I'm willing to pay more taxes to take care of the sewerage.

"As time goes on we are going to produce more and more vegetables to the south of Durango. It is my contention that water that is contaminated and is used to irrigate vegetables can be a source of spreading disease through the vegetables.

"To my way of thinking water is the greatest resource we have here in the West. We cannot afford to waste the utility of water by allowing it to be polluted." - Respectfully submitted, Elvin T. Cobb, 1061 Fifth Ave., Durango, Colorado.

That shows a picture of garbage scattered over the area at the Silverton dump grounds, later on to be pushed into the river.

That shows a picture of the garbage as it was bulldozed up to the river at Silverton.

We have another picture taken by a technician of the Colorado Fish and Game Department, showing the carcasses of two dead animals, and showing portions of two carcasses partially consumed by fire.

(Pictures not inserted in record)

Our President took a lot of slides that we had hoped to show at this meeting. We have a projector and a lot of slides showing the contents of the garbage and sewage and the conditions along the bank at Durango; also different points of pollution we had hoped to bring up at this meeting.

MR. STEIN: Thank you, Mr. Bruce. I should like to emphasize, before we throw this open, that the jurisdiction of the Public Health Service only relates to the affects of the pollution in New Mexico. We have no jurisdiction over intra-state pollution as far as enforcement is concerned. Our role there is to provide technical aid and assistance to the States.

Do we have any questions from New Mexico?

DOCTOR LELAND: A question I will bring up later -- I very much appreciate the statement by the gentleman, which presents an interesting situation which is also of concern to New Mexico, in addition to the radiation situation which we have been discussing this morning -- I respectfully refer the situation to Doctor Cleere.

DOCTOR CLEERE: Thank you. It is also nice to have Mr. Gahr, our Chief Sanitary Engineer, to whom I refer the matter.

MR. GAHR: Mr. Bruce, you refer to a letter dated July, 1954, and I believe that you merely extracted portions from the letter.

MR. BRUCE: I have the letter here if you care to refer to the whole letter.

MR. GAHR: I would like to have the complete letter for the record.

MR. STEIN: This seems to be an intra-state situation rather than inter-state. The Public Health Service only has jurisdiction over inter-state problems. Would you like to have the entire letter read?

MR. GAHR: In the interest of saving time, Doctor Cleere, and myself both agree we can dispense with it.

MR. STEIN: I do not know that we need the enclosed correspondence. However, about the last that you have written -- would you like to see that phase, Mr. Gahr?

MR. GAHR: Yes -- It is quite a long one isn't it?

MR. BRUCE: I made the statement there about us being a step-child -- We kind of accidentally received the news that there was going to be this meeting here, and while we were not in very good graces with some people around Durango, there are those who appreciate what we are doing and are supporting us financially.

MR. STEIN: For the purpose of the record, do you have a copy of your letter of July 13, 1954?

MR. GAHR: Yes. I would like to have the entire letter entered in the record.

MR. STEIN: Are there any further questions or comments?

DOCTOR CLEERE: I think Mr. Bruce should be commended for his interest in the problem.

MR. STEIN: Thank you for coming.

MR. BRUCE: We appreciate your kindness in allowing me to present my statement.

(LETTER ENTERED AS "EXHIBIT C")

MR. STEIN: Do you have any other participants from New Mexico?

MR. CALDWELL: One thing we are interested in -- these pictures were taken in 1955?

MR. BRUCE: Some in 1955 and some in 1956. These pictures, these slides - if you want to see them, were taken just last year.

MR. CALDWELL: Inasmuch as these exhibits would have a bearing on our initial proposal, could we see them this afternoon?

"EXHIBIT C"

STATE OF COLORADO
DEPARTMENT OF PUBLIC HEALTH
State Office Building
Denver 2

July 13, 1954

Mr. W. L. Bruce
Secretary-Treasurer
Animas River Water Users, Inc.
R.F.D. No. 1, Box 65½
Durango, Colorado

Dear Mr. Bruce:

Thank you for your interest in the water pollution control problem as it effects the Animas Valley residents as well as those farther downstream in New Mexico. I can assure you the State Health Department also wants progress in pollution abatement. However, there are times when another need is more pressing.

I should like to point out that there is a very great need for the people of Durango to have a safe and adequate public water supply system. Our concern of the need for a safe public water supply system was expressed by the extent to which the State Health Department has gone to convince the city officials at Durango that such a need was highly important. We also learned from the Durango officials that they have great problems of financing which make it necessary for them to proceed, as in this case, with one project at a time. Because Durango now has two Imhoff tanks and four septic tanks through which their sewage is passed, it seemed reasonable that the greatest emphasis should be placed on securing a safe water supply, not only for the people of Durango but for the countless hundreds of sportsmen and tourists who come to that city during each year. Please understand that we do favor a modern sewage treatment plant for Durango, the same as for many of our Colorado cities, but I think you will agree that of the two items, the need for a safe public water supply is far more pressing and should be provided first.

Relative to the sewage problem at Silverton, it is agreed that domestic sewage should receive at least primary treatment. However, the City of Silverton points out its sewage is diluted by large quantities of water. Upstream from Silverton at Howardsville the lowest recorded flow in 1943, which occurred in March, was 13 cubic feet per second. At the same place during 1944 the lowest flows occurred during January and March and were 15 cubic feet per second. The water from Mineral Creek is also available for dilution. I think this gives you both sides to the sewage problem at Silverton.

As to the complaint made by the people residing on the Florida River watershed, these have been investigated by the San Juan Basin Health Department and they found no evidence of untreated sewage being discharged to the stream. However, evidence of contamination by wild life, sportsmen, livestock, soil erosion and picnickers was found. Such pollution is a normal thing and it is very doubtful if it can ever be prevented unless the water shed is completely cleared of livestock and denied to all people except caretakers of the watershed.

"EXHIBIT C" - 2

Again let me say that I greatly appreciate your interest in giving consideration to the problem of pollution control. Your interest is very valuable because in the last analysis it will take many people, working together, to get our water courses cleared of pollution where it exists in dangerous amounts.

Sincerely yours,

(Signed, R. L. Cleere, M. D.)

R.L. Cleere, M. D., M.P.H.
Executive Director

RLC-WNG:gas

"EXHIBIT C" - 3

R.F.D. No. 1, Box 65½
Durango, Colorado
June 12th, 1954

Dr. Roy L. Cleere, Director
State Health Department
Capital Annex
Denver, Colorado

Dear Sir:

I attended the public meeting between you and the members of the City Council at Durango. After listening to the discussions of the agreements that were made and hearing Mr. McGlone promise the city council that if the agreements were complied with that the City of Durango would not be bothered for a long time about any improvement to the present sewerage system by the State Health Board.

It appears that the residents of Durango are going to get about everything they voted against but will still have the privilege of dumping raw sewerage into the Animas River indefinitely.

So Durango sportsmen will continue to have sewerage fattened fish and there is not enough people using Animas River water for domestic purposes between Durango and the New Mexico line to create any political problem and what is found below the state line will be the problem of our neighbors in New Mexico. We are not too much concerned about conditions of the Animas River south of Durango only to help everyone get clean water.

Animas Valley residents who use river water for irrigation and domestic purposes are concerned about pollution and contamination of the river and irrigation ditches north of Durango. It is also their desire to help keep the river clean as a sportsman and tourist fishing attraction.

At the present time there is some half a dozen places in Durango that raw sewerage is going directly into the Animas River and at times it is reported the disposal plant is overtaxed and untreated sewerage goes through it.

Silverton has already dumped their sewerage into South Mineral Creek, about 500 yards from the Animas River and for years have used a flat piece of ground along the Animas River bank for a city dump ground for garbage, manure and city trash. What will is burned, balance is shoved into the river with a bulldozer.

Residents of the Florida River have complained to our organization of places of pollution and contamination on that river.

The Animas River Water Users Inc., sponsored by the Animas Valley Grange 194, was formed for the purpose of getting clean water for ourselves and to help the community keep the streams clean of mine tailings and sewerage pollution as a tourist fishing and recreation attraction.

"EXHIBIT C" - 4

There is some confusion on the interpretation of the present laws governing stream pollution and contamination. The interpretation seems to be in favor of the big corporation and those with political pull.

I was instructed by the directors of the Water Users, Inc., to write you to see if other known points of pollution and contamination would be accorded the same consideration as that given Durango by the Health Department.

An early reply will be appreciated.

Yours truly,

(Signed, W. L. Bruce)

MR. STEIN: Let me point out that for the purpose of the record, introduction of slides is one of the most difficult things -- they just do not help. We have two areas of concern here. One, is the possible problem of radiological material; and, two, a composite of municipal and other wastes such as refuse dumps being put into the river, domestic sewage wastes of a liquid nature, and possible leaching wastes from mining operations in abandoned mines. We may have to come up with some recommendations for solutions as the proposed study progresses. The Colorado people might come forth with a pretty complete report on some of these areas under consideration, so we can make a determination of what progress is being made in these areas and what we can do to help correct them. I have no objections to the slides if the folks here want to look at them, but we must recognize that slides do not show in the record.

MR. BRUCE: We realize that we made a mistake in presenting the slides; but the President of our organization took these pictures as evidence of the contamination discussed.

MR. STEIN: Thank you very much.

DOCTOR LELAND: Do you want to break for lunch?

MR. STEIN: If there is no other material from New Mexico, I think we can complete this within the next ten or fifteen minutes. I do not know who else you might want to have participate on the New Mexico side. Do you want to call on other participants?

MR. CALDWELL: We have several others -

MR. STEIN: Let's break for lunch. It is now 12:30. Would it be possible to be back in an hour - hour and fifteen minutes? How long does it take here --?

DOCTOR LELAND: Sometimes it is slow and sometimes it is fast --

MR. STEIN: Let's adjourn and try to be back by 1:30.

* * * * * * * * * * * *

1:45 P.M.

MR. STEIN: May we reconvene? Before we call on New Mexico, I think AEC may have one additional statement to make. We will call on the AEC Representative, Mr. Robert F. Barker, Division of Licensing and Regulation.

MR. BARKER: Barker, Atomic Energy Commission, Washington, D. C. Division of Licensing and Regulation.

I would like to add one phase of the licensing program which was not mentioned earlier. The operations of the mills for recovery of vanadium has been a continuing process for several years. Early radium recovery was instituted; uranium was a fairly recent development in this processing of rare earths. The recovery was instituted by the government primarily. As such, this was not subject to the same types of controls as those items covered in vanadium recovery mills. At the same time there was money being supplied in development of the uranium recovery program. Several research programs were subsidized for development of uranium fields and discovery of uranium ores.

This was part of the program. The licenses which were issued for uranium processing -- most of them were issued in 1946. At that time there were no legal limits established. As a matter of fact, the legal limits were instituted, or were actually made effective only as of March 1, 1957. This is the Part 20 Standards for Protection Against Radiation which was referred to earlier.

Therefore, this is one explanation for the apparent lack of activity, on the part of the AEC, to see that these regulations were being complied with. There were no effective federal regulations prior to March of 1957. I did want to add that, in particular the survey which was made last year, we found the mills very cooperative in research-type surveys, where we were interested in spot samples; and at the same time we have from Mr. Walker a statement that the mills have been very cooperative in the inspection effort. It is anticipated that there will be no problems with regard to our conferences by correspondence, the compliance effort which the Division of Licensing and Regulation makes.

I wanted to emphasize, contrary to impressions that might have been given in the earlier statements, our AEC Operations are not of the clobbering type of operation, they are of the cooperative program type. We do have regulations which must be met. To do this, we will offer every assistance that we can, within our own limitations; we will cooperate with the mills in achieving compliance; we will not, in a sense, move in with the idea of trying to put them out of business because that in turn would put us out of business.

MR. STEIN: Thank you, Mr. Barker. Now we will call on New Mexico. Do you have any other participants you would like to call on now?

DOCTOR LELAND: We have quite a number. Mr. Caldwell will introduce each person.

MR. CALDWELL: We would like to ask Doctor Warren Rasmussen, District Health Officer, San Juan County Health Department, with headquarters in Aztec. We would like to ask Doctor Rasmussen if he has anything he would like to add.

MR. STEIN: May I ask the participants from now on, if we are going to complete this afternoon, to try to confine their remarks to about five minutes. If they have any other additional material, we will be happy to put that in the record and give that full consideration. Doctor Rasmussen --

DOCTOR RASMUSSEN: I do not have a formal statement, but I would like to express the grave concern that we have in our area, concerning interstate stream pollution. Not only is it our official responsibility, but we are also the ones living up there who are ingesting these pollutants. We of course have been concerned about the sewage pollution in the Animas River and the San Juan River, because we have probably two or three thousand people who are drinking raw river water. We are not proud of it.

However, our attention was focused on the problem of industrial waste pollution last summer. We received several calls from sportsmen, stating that on two different occasions there was a marked turbidity and discoloration in the Animas River. On one occasion a local clergyman, who is also a sportsman, followed the river back up to its source and found it to be at the Vanadium Corporation Plant in Durango.

There is a new school of thought among the anglers; some of them would like to have some radiation pollution so that the fish will develop two heads, and they will stand a better chance of biting, they say --(Laughter). We are concerned about this and we are trying to minimize the public reaction to is. Needless to say we do not want to start a panic up there. We had a panic last year when an acid truck overturned in the Animas River. People as far down the river as seventy-five miles were getting all sorts of mysterious symptoms. We have had as recently as last week, a physician who happens to be the Chief of Staff of the San Juan Hospital, asked us what we were going to do as the Health Department, about the possibility of radiation pollution of the Animas River. We are, therefore, concerned about it.

We were happy that we could assure him that there was going to be a conference this week, and things are starting to move. I would like to suggest this possibility; that if there is a survey made in that area, there has been concern expressed about the possibility of underground pollution of the San Juan River from the plant in Shiprock. It might seem a simple matter to include that area in whatever survey is made.

I would like to state that we in that County Health Department, are interested in cooperating in any way we can, with our facilities and with our staff. We are already starting to collect samples, and I can say we are eager to go.

MR. STEIN: Are there any questions from Colorado?

MR. GAHR: None --

MR. STEIN: Are there any from New Mexico?

MR. CALDWELL: The next man we would like to call on is Mr. Warren Griffin, who is the Chief Sanitarian of the San Juan County Health Department.

MR. STEIN: Mr. Griffin.

MR. GRIFFIN: I do not have any formal type statement to make, but as Doctor Rasmussen says, we are vitally interested and we will cooperate with anyone, anywhere, in straightening out the problem. We will make our personnel and our facilities fully available.

MR. CALDWELL: The next person we would like to call on is Mr. Robert Morfitt, who is with the Indian Health Facilities, Public Health Service.

MR. MORFITT: Thank you, Mr. Caldwell, and Mr. Chairman.

Mr. Caldwell, earlier in his presentation, mentioned some of the downstream users on the San Juan. We realize you are mainly concerned with the Animas River, but we would like to point out some of the interests immediately downstream from the Animas River as it enters the San Juan River. Commencing at the edge of this map right where it is cut off (referring to map), and running some twenty-five miles downstream, are a number of Indian families. This is about the edge of one portion of the Navajo Reservation. Within this area there are probably some 3,000 Navajos living along the river on some of the irrigation projects. These people make considerable use of the river for domestic water uses, for irrigation, for recreation, and stock watering.

I thought it might be of some interest on the special problems of the Navajo, there may be some need from the people living in the Animas River Basin, in that the Navajo utilizes for food only that which he can raise and produce within the irrigated area or on that range immediately adjoining the river. So that if there is a problem of concentration in the meat sources, or in green vegetables, the Navajo family in this area has as a meat source the sheep that are grazed on the irrigated land and watered in the river or in the irrigation ditches.

In addition, as Doctor Rasmussen says, we don't like to admit it, but many of these people drink raw water directly from the irrigation ditches or from the river. Whatever vegetables or green crops are those that are raised in the valley on irrigated land. These people may present somewhat of a unique problem in that all of their food crops are raised basically in this valley. They are not supplementing their meat from cattle raised in Colorado or hogs raised in Kansas; they are not importing green or fresh vegetables; so that whatever vegetables they use are local products. If this is a problem, we would like the conferees to take into consideration whether or not additional studies might be of value on some of the Navajo lands.

In addition to the 3,000 people who live in the immediate area, there are several domestic sources taken from the river, such as BIA installations at Shiprock which at present are using approximately one-half million gallons of water per day, and two or three schools in that region immediately below Farmington utilizing approximately another one-half million gallons per day.

I believe that is all I have, Mr. Chairman.

MR. STEIN: Thank you. Do we have any questions from Colorado?

MR. GAHR: No question, just a comment. I am in complete sympathy with what Bob has said, but would like to point out that the primary purpose of this study in the area under consideration, and if the funds are sufficient to do that, well and good; otherwise, I think we should keep in mind that everything should be concentrated on that particular area --

DOCTOR LELAND: I would like to comment, I speak also for Colorado; both Health Departments are completely collaborating with Indian Health in

facilitating this particular study, and we will do our best to keep you informed, as if you were one of our own. (Laughter)

MR. STEIN: Thank you.

MR. CALDWELL: We would now like to call on Mr. Lester Blaschke, Chief Sanitary Engineer with the Indian Health Facilities in Albuquerque.

MR. BLASCHKE: I have nothing to add. Mr. Morfitt has presented the interest and concern of our office regarding this matter under discussion.

MR. CALDWELL: Thank you, Mr. Blaschke. We invited some of our neighboring states to be represented, and Mr. George Marx, State Sanitary Engineer of Arizona is here.

MR. MARX: First I would like to say I appreciate that invitation very much. I have really learned a lot. We in the Lower Colorado River Basin are happy to learn that the Upper Colorado River Basin is instituting a program of cleaning up the Upper Colorado River in order to maintain the quality of the water in the Lower Colorado River. At least we are getting a start. (Laughter) As you know, there is a dam going in Glen Canyon which will be a good catch basin to catch those gross solids that were spoken about this morning. That will practically stop them at the Utah line. But seriously, we are interested in these alleged radioactive wastes as they may affect the quality of the water down below. We have many irrigation projects and domestic water supplies in the Lower Colorado River Basin.

That is about the extent of my comments, Charlie.

MR. CALDWELL: Thank you, George. We asked a representative from Utah to be here, and we have Mr. Calvin K. Sudwicks --

MR. SUDWICKS: I would like to thank you for the invitation also. I am here representing the Utah Water Pollution Control Board, and I am just an observer. Thank you very much.

MR. CALDWELL: We also have invited a representative of the New Mexico Game and Fish Department, Mr. R. L. Brashears.

MR. BRASHEARS: Outside of expressing concern over the pollution of any of our waters, I do not have a statement to make. Thanks.

MR. CALDWELL: Mr. Steve Reynolds was here --, Mr. Spiegel do you care to add anything for the State Engineer's Office?

MR. SPIEGEL: No.

MR. CALDWELL: Are there any of the towns, Farmington or Aztec, or any of the people from San Juan County who have not spoken? Are there any of those people here?

We would like to ask Mr. Robert P. Lowe, Chief of the Water Pollution Control Branch of the New Mexico Health Department, if he has anything he wishes to add to this discussion.

MR. LOWE: I have a couple of points I would like to bring out. First, Mr. Morfitt has stated that there are perhaps two or three thousand Indians downstream from the Farmington area, who use that surface water in various ways, probably mostly for domestic purposes. I would like to bring out the point that in this area, one of the things that makes it serious in regard to pollution of any sort, is the fact that there is a very poor quality of groundwater. It is not obtainable in most of the entire area; they have to depend on surface water. That is one of the reasons that we are concerned about the pollution of the Animas and in turn the San Juan River, where they come together on the edge of that map down here at the bottom. Also, I think it has been brought out by Mr. Caldwell and by Mr. Krause; first on the ultimate development of the San Juan River Basin. We have been approached, and there are plans on the development of the Animas River Basin that will drastically change the river flow. Now there have been figures mentioned this morning about the various dilution factors. Those will be non-existent, it will be drastically changed, there will not be dilution in the river below Durango that there is most of the time now.

We have reviewed preliminary reports on the development of the Animas River, which call for a diversion dam above Durango for diverting the river into La Plata River Basin for irrigational purposes. It will use all of the available water, except a small amount for fish life on the lower part of the Animas River and of course allowing for existing irrigation rights along the river below Durango and in New Mexico on the Animas River. That will change the picture quite a bit from what it is right now.

There has not been much mentioned in the way of chemical wastes in relation to the pollution of the Animas River, except by mining above, and of course there are chemical wastes being discharged from the mill process at Durango. I think those items should be considered in this overall survey. We of the State Health Department in the past assumed the AEC was attending to this problem, or had some control, and because of the nature of the National Defense Effort it was pretty well kept quiet. As you have mentioned, the AEC has just recently gone into surveying these mills, in December of 1957. In other words, it is quite a recent development on actually some action in this direction.

MR. STEIN: Do you have any questions or comments? (to Mr. Gahr)

MR. GAHR: No, I do not.

MR. CALDWELL: The next man we would like to ask if he would like to contribute, is Mr. Carl R. Jensen, who is our Supervisor of Occupational Health and Assistant Division Director of Environmental Sanitation Services.

MR. JENSEN: There is very little to contribute at this time. I have worked with the men in AEC and have enjoyed it a great deal. We have worked together on the isotope program, very little, just initiating our activities together on the mills. We have been in the mill work long before the first mill was built in New Mexico. Since our first experience with that, we have been working closely with every mill prior to construction to determine how they are going to dispose of their effluents - their wastes. Our main concern has been the contamination of underground waters. In this we have received extremely fine cooperation from the mill owners.

MR. CALDWELL: Thank you, Carl. The next man we would like to ask is Mr. John W. Hernandez, Associate Engineer, Water Pollution Control Section, New Mexico Health Department.

MR. HERNANDEZ: No comment, Charlie.

MR. CALDWELL: The last person we are going to call on, she has been a faithful attendant and we would like her to express any views she may have. Miss Robinson, do you have anything you would like to say?

MISS ROBINSON: I have no comments. I am only listening.

MR. CALDWELL: I think that concludes the list of people we have.

MR. STEIN: Thank you. I think the way this has developed, we can probably attempt, unless you want some discussions of the proposals, a combination summary and discussion point by point.

DOCTOR LELAND: We have persons here from the two Regions -- one of course is at the table, but also we have Mr. Alexander, Region VIII--

MR. STEIN: Oh yes, we would like to introduce first, Mr. Garth, Regional Engineer for Region VIII, Mr. Alexander of Region VIII, Mr. Fooks of Region VIII, and Mr. Schreeder of Region IX; also, Mr. Joe Anderson of the Dallas Office.

The reason all of you folks are here, as you can see, this is a relatively new procedure and it is evidently a problem common to all of the Regions in this area. Therefore, I think it will probably have considerable significance.

If we would attempt to summarize this and try to get agreement as we summarize, we can divide the problem into two kinds of pollutants:

(1) Radioactive wastes,

(2) Other types of wastes.

First, I think we can go back and examine the provisions of the Act. We can all agree from looking at the map --

MR. GAHR: Excuse me, Mr. Chairman. There is something that has been brought to my attention by Mr. Barnard, relative to comments made earlier on the matter of the San Juan below Farmington, and the whole problem that involves irrigation diversion of waters. Frankly, I am not at all well acquainted with this, Mr. Barnard is much better versed. For the record, I would like to say that the whole thing should be considered as an entity. There are diversions of many points, and I think this is what he had in mind.

MR. BARNARD: Barnard, Colorado. Before any question is raised concerning the potential effect of the Animas-La Plata project on dilution waters; if those are going to be considered, then I think all of the potential projects in the Upper Colorado Basin ought to be considered, including New Mexico San Juan-Chama Diversion and the Navajo Indian irrigation project which will represent a water use of something over twenty times the proposed Animas-

La Plata project. I make that statement in reference to the statement that it would increase the problem by virtue of the potential Animas-La Plata project which has not even been given a feasibility report as yet; unless also consideration is given with respect to the San Juan-Chama and Navajo Indian irrigation projects which are probably of much greater significance from the standpoint of dilution water below Farmington.

MR. STEIN: I think that point is well taken. Now, let me say that in any of these pollution cases, and just to clear this up and give a little background -- in any case involving pollution of interstate waters we necessarily devote ourselves to a rather narrow field, because in the past one of the problems in dealing with cleaning up pollution is that we have been too diffuse. We have had reports, for example, to mention others, on the Ohio River, the Mississippi River, on the Potomac River, and they are so big and involve so many factors that we just can't get at it, and nothing seems to be done over the years.

The technique we are trying to use in the administration of the Act, is to take a relatively small segment of the problem such as we have here, the pollution of the Animas River, and try to deal with that - just dealing with our problem. Now in the report, in any consideration necessarily the report will go over into other areas:

(1) We will get the diversions or proposed diversions, but they will just be part of background material.

(2) Possibly more immediate would be the question of the Indians down below. Obviously, that gets broader. Theory, of course, here is that if you would eliminate pollution, if that pollution existed, as it came into Aztec and Farmington, there would be very little likelihood that any of it would get down below to the Navajo Reservation. You would get that increment anyway.

That is the kind of theory we work on. Actually, we can find our efforts get very diluted if we begin to spread them out and explore all these problems to their ultimate conclusions. I am sure that Doctor Tsivoglou and all the rest of the folks working on the study, will take these things into account and put them in proper perspective. I think we will just have to evaluate if something has been given a feasibility report; or even if it has, how far away from fruition.

Now, to get back to summarizing; if we look at the statutory requirements, we have jurisdiction over pollution of interstate waters originating in one State affecting people in another State. I do not think there is any doubt that the situation described here today meets that requirement.

The next three points required to be covered by statutes:

(1) Occurrence of pollution of interstate waters subject to abatement under the Federal act,

(2) Adequacy of measures taken toward abatement of pollution, and

(3) Nature of delays, if any, encountered in the abatement of pollution.

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Probably, from the material presented here today, we are too early to attempt to delineate with any specificity. We would have to wait perhaps another session of the conference to do that. Therefore, I would suggest, as I gather from the concensus of the conferees, that we consider this the first session of the conference, with other sessions to follow.

As pointed out before, it probably would be best to divide this problem into two areas:

(1) Pollution from industrial sources having radiological significance or radiation significance, and

(2) Wastes from other sources.

As I understand from the material presented today, the wastes from other sources are of various kinds:

(a) Wastes from refuse or garbage, or what we would call ordinary garbage disposal or a dump, which are alleged to be getting into the Animas River,

(b) The normal liquid and such incidental industrial wastes as we get from cities, going through city sewer systems. These may or may not be getting adequate treatment when they involve wastes from up around Durango and Silverton,

(c) Wastes from mining operations in that area, and probably wastes from abandoned mines.

I do not know that again we have enough specificity in that, but I think the outlines of the problem have been clearly indicated here.

What I would suggest is that Colorado prepare for the other conferees, by July 1, a report on the situation as it exists, as they find it, with reference to all of these aspects of the problem: (1) refuse, (2) domestic wastes from sewage, and (3) mining operations and abandoned mines; with possible recommendations for consideration by another session of the conference. This might include a specific recommendation with relation to Durango which may develop at that time, and perhaps a time schedule for Durango and these other folks to institute remedial measures, if such measures are indicated. That can be taken up by the conferees again when they reconvene. Very possibly a good many of these problems can be solved just in the getting of this report together for the conferees, by Colorado working with the people involved in the area.

The next point we have is the wastes due to the uranium milling operations in Colorado. The Public Health Service and Doctor Tsivoglou have made a suggestion as to a study that the Public Health Service has prepared and intends to embark on in the near future. As I understand this, the Public Health Service may start routine sampling almost immediately. However, the blueprint for the plan has been presented at this conference. If when we have had several suggestions made as to things which might be included; also the States of Colorado and New Mexico, and the AEC were invited to participate in this study; I think the precise and specific details obviously will have to be worked out.

At this point I would like to ask both States whether in principle they agree that it would be a good idea to cooperate and work together with joint State-Federal plans, along the outlines presented by Doctor Tsivoglou.

Is that agreeable to Colorado?

DOCTOR CLEERE: Yes.

MR. STEIN: How about New Mexico?

DOCTOR LELAND: It is agreeable to New Mexico; but here I should like to ask my Chief of Laboratory who is considerably interested in this subject, if he has any comments. Doctor Johnson, do you have anything to say?

DOCTOR JOHNSON: The Laboratory service is certainly interested in cooperating on this, and we will offer the full services of our facilities and our staff to assist with this program. Also, with the assistance of the Public Health Service and the Atomic Energy Commission in further development of this program.

MR. STEIN: I would recommend that as part of the summary, Doctor Tsivoglou take action to set up this technical study of the Animas River, and work out the details with the States concerned, and with the AEC to the extent that they wish to participate in the study; and that the detailed specifications be submitted to the conferees prior to the end of next month, which is by June 1. Hopefully, we will try to get the summary and a transcript out by then. That largely depends on the stenographic services, and this is a big job. It doesn't take very long to get those out once you have received them. I think that it is realistic to expect that we will probably have those sent back and duplicated in a month. It will be very helpful if we can in that package put in the detailed plans for the surveys.

This does not mean of course that routine sampling which is indicated should not be instituted before that, or immediately, if you think it is appropriate, or the folks developing the study think this is appropriate.

Next, I want to indicate that as soon as the folks engaged in the study can come up with positive recommendations, even though these be interim recommendations, that they forward these recommendations to the other conferees; if it is thought appropriate then the conference can be reconvened on the call of the Chairman to consider these.

Again, aside from a conference to reconsider such interim proposals, I think we should be in a position to come up with rather definite proposals in perhaps the concluding session of the conference, no later than one year from this date; and certainly as much before that as the study group can possibly give the conferees an indication that they have positive proposals, so that we can come up with relatively definitive conclusions and recommendations. Again, that conference will be upon the call of the Chairman.

Is there anything that any of the conferees, or anyone, wishes to suggest or add to the summary?

DOCTOR CLEERE: As a point of clarification, in your summation you have outlined a complete survey program of the Animas River with the State Health Departments of Colorado and New Mexico assuming the primary responsi-

bility for the study other than the portion of the study relative to radioactive wastes. I am trying to visualize the procedure of dove-tailing the studies, in other words. As I say, it would be well if we had someone to prepare a format for this complete study, with the Public Health Service making the contribution for the radioactivity study.

MR. STEIN: Perhaps I was not too clear. I did not mean to imply that there would be two studies. I think there will be one, which will be a complete study. As a matter of fact, under the law that we have, I think we are obliged in an interstate pollution situation to consider all aspects of the pollution, not just radiological aspects. Even if we wanted to, which we don't, we could not limit ourselves that way. We will assume for the Public Health Service the responsibility for a complete study, with the participation, as much as possible, and cooperation of, the States concerned.

What we are talking about at first was just a report on these three factors dealing with other types of wastes, so that at the next session of the conference we can come up with pretty definite recommendations.

As relates to the other sources of pollution, I do not think we have enough information at the present time to come up with, say, a recommendation for the time schedule if one is indicated, for treatment at Durango; and that is what we would like to come up with.

I do not know that the solution of these problems is necessarily as complicated as the one we are facing in radiological health, and therefore we may be able to come up with pretty definite recommendations as to the other aspects of pollution prior to the year from now, and that was the sole purpose.

Do you have anything further to add to the summary?

MR. CALDWELL: No, I believe that covers it.

MR. STEIN: Does anyone else here want to say anything in relation to this problem, or any aspect of the conference? If not, I declare the meeting adjourned at the moment.

I want to thank you all for coming and for participating. Hopefully, I think we are well on the way to an equitable solution.

The conference is adjourned.

* * * * * * * * * * * (2:45 P.M.)

APPENDIX A

ATTENDANCE ROSTER

Conference on Interstate Pollution
of the Animas River, Colorado-New Mexico
April 29, 1958

P. D. Akin	State Engineer's Office, Santa Fe
Aleck Alexander	U. S. Public Health Service, Denver
J. B. Anderson	U. S. Public Health Service, Dallas
Robert F. Barker	U.S. Atomic Energy Commission, Div. of Licensing & Regulation, Wash. D.C.
John B. Barnard, Jr.	Assistant Attorney General, Denver
Lester E. Blaschke	U.S. Public Health Service, Indian Health Division, Albuquerque
Robert L. Brashears	N.M. Dept. of Game and Fish, Santa Fe
Fred A. Brinker	Vanadium Corporation of America, Durango
W. L. Bruce	Animas River Water Users Assn., Durango
Charles G. Caldwell	N.M. Dept. of Public Health, Santa Fe
C. W. Christenson	Los Alamos Scientific Laboratory Los Alamos
Roy L. Cleere, M. D.	Colorado Dept. of Public Health, Denver
J. H. Fooks	U. S. Public Health Service, Denver
William N. Gahr	Colorado Dept. of Public Health, Denver
Edmund Garth	U.S. Public Health Service, Denver
D. R. George	Nat. Lead Company, Winchester, Mass.
Warren Griffin	San Juan County Health Dept., Aztec
T. J. Haycock	Albuquerque Operations Office Atomic Energy Commission
John W. Hernandez	N.M. Dept. of Public Health, Santa Fe
Carl R. Jensen	N.M. Dept. of Public Health, Santa Fe
Daniel E. Johnson, Ph.D.	State Public Health Laboratory Albuquerque
W. R. Kennedy	Los Alamos Scientific Laboratory Los Alamos

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Keith S. Krause	U. S. Public Health Service, Dallas
Stanley J. Leland, M. D.	N.M. Dept. of Public Health, Santa Fe
Robert P. Lowe	N.M. Dept. of Public Health, Santa Fe
A. B. Luke	Animas River Water Users Assn., Durango
John J. Lyon	Animas River Water Users Assn., Durango
George W. Marx	Ariz. Dept. of Public Health, Phoenix
Paul W. Masters	N.M. Dept. of Public Health, Santa Fe
John A. Maxwell	Vanadium Corporation of America Durango.
F. E. McGinley	U. S. Atomic Energy Commission Grand Junction Operations Office
Richard L. Moore	Colo. Dept. of Game and Fish, Denver
Robert P. Morfitt	U.S. Public Health Service, Indian Health Division, Window Rock, Arizona
Warren A. Rasmussen, M. D.	San Juan County Health Dept., Aztec
Gruine Robinson	N.M. Dept. Public Health, Santa Fe
W. B. Schreeder	U.S. Public Health Service, San Francisc
Zane Spiegel	State Engineer's Office, Santa Fe
Murray Stein	U. S. Public Health Service Washington, D. C.
Calvin K. Sudwicks	Utah Dept. Public Health, Salt Lake City
J. D. Torrey	Colo. Dept. of Public Health, Denver
Dr. E. C. Tsivoglou	Robert A. Taft Sanitary Engineering Center, Cincinnati
Dr. D. E. Walker	U. S. Atomic Energy Commission, Idaho Operations Office, Idaho Falls
Dr. Francis J. Weber	U. S. Public Health Service, Denver
A. J. Whitman	U. S. Atomic Energy Commission Albuquerque Operations Office

The Disposal of Radioactive Wastes

(By LeRoy W. Van Kleeck, B.S., principal sanitary engineer, bureau of sanitary engineering)

The safe disposal of radioactive wastes is a growing problem in Connecticut. When the Congress of the United States passed the Atomic Energy Act of 1954, it gave the U.S. Atomic Energy Commission the authority and responsibility for the regulatory control of special nuclear materials, sources materials and byproduct materials to assure the common defense and security of the country and to protect the health and safety of the public. Representatives of the Atomic Energy Commission have voiced the hope that the States will relieve the Commission by assuming some of the responsibilities for the controls delegated to it.

In 1957 the Connecticut General Asembly passed Public Act 154, for the control of sources of ionizing radiation to protect the public health. This act is administered by three bureaus in the State department of health: (a) the bureau of sanitary engineering in measures to control radioactive contamination of the air and water in the environment; (b) the bureau of industrial hygiene in measures to protect industrial workers; and (c) the bureau of laboratories in the development and carrying out of analytical techniques and measurements for determining the amounts of radioactivity. This department, together with other State departments interested in ionizing radiations, also consults and coordinates its activities in this field with Mr. Henry Marx, coordinator of atomic development activities in Connecticut. Under the authority of Public Act 154, the department enacted regulation 287 in the sanitary code of the State. This regulation applies to the manufacture, use, storage, handling, transportation, and disposal of all sources of ionizing radiation and all radioactive materials except as specifically exempted therein. This discussion deals with one phase of the department's activities in this field: The safe disposal of radioactive wastes.

USERS OF RADIOACTIVE MATERIALS HAVING WASTE DISPOSAL PROBLEMS

The users of radioactive materials having a waste disposal problem embrace large and small operations. Two firms in the State manufacture uranium fuel elements for atomic reactors. Fuel element wastes include gases with airborne particles, and solids and liquids containing principally traces of waste uranium. One concern has two experimental reactors. The wastes from these reactors to the environment are principally gases or airborne particles. It is expected that other industries and institutions will install experimental reactors in the near future.

Another firm is assembling, servicing, and replacing reactors in submarines. The disposal of various radioisotopes or fission products in solid and liquid form is involved in some of these operations.

Radiochemical laboratories at several installations produce solid, liquid and airborne radioisotope wastes. In addition, there are other laboratories conducting animal experiments, plant studies, and various industrial applications with radioisotopes. Animal and plant wastes are a part of the disposal problem in these cases.

A number of hospitals are using radioisotopes for medical diagnosis and treatment. The wastes are principally liquid and these are discharged to sewers after decay and/or dilution, as required.

Another firm has a large-scale operation for the development of nuclear-powered aircraft. Wastes to date include solids, liquids, and airborne particles of a very low order of activity. The expansion of operations may change this status.

DISPOSAL AND TREATMENT OF RADIOACTIVE WASTES

Liquid wastes.—Liquid wastes, from fuel fabrication plants, submarine servicing and laundering are discharged to holding tanks where they are monitored for radioactivity. Liquid wastes are produced from pickling liquor rinses, floor washings, discontamination operations, washing of mechanical equipment or clothing, cooling waters and the like. If the level of activity is below the permissible standard set by the department, the wastes may be discharged to the environment. Discharges may be to streams or sewers. If the level of activity is above the permissible value, the liquid wastes must be further treated by one or more of the following procedures:

(1) Diluted with nonradioactive water.

(2) Filtered to remove nonsoluble particulate matter.

(3) Passed through demineralizers or ion-exchange columns for removal of most of the activity.

(4) Chemically treated for precipitation, concentration or pH correction of the waste, so that removal of radioactivity is more effective by demineralizers.

(5) Stored in special holding tanks for decay of the activity.

(6) Packaging and transportation of wastes, whose activity cannot be reduced to safe levels, to designated disposal areas outside the State of Connecticut, as laid down by regulations of the U.S. Atomic Energy Commission. These wastes are usually so-called high-level wastes. Some of these wastes contain uranium which is recovered by the AEC. The AEC installation at Oak Ridge, Tenn., receives most of such wastes from Connecticut. Usually such wastes are segregated from the holding tank system for such disposal.

In addition, the department requires a sampling device on the main discharge pipe from these installations for the purpose of collecting a 24-hour composite sample of the discharges. These samples are examined by the plant's technical staff and also held at least 24 hours for duplicate testing by this department at any time. These composite samples serve as a check on the character of the overall discharge, thus serving as evidence of effectiveness of monitoring sampling of individual holding tanks. Such monitoring of individual holding tanks is the principal method of control.

Records of activity of all liquid discharges must be kept by these installations and some have been requested to forward monthly reports to the department.

At the concern in Connecticut building atomic submarines, an interesting variation in diposal practices is in use. A barge has been built specifically for this purpose, and it includes areas for decontamination of parts, a monitoring room, shower room, first aid room, laundry room and a basement room containing holding tanks, demineralizers, pumps, samplers, etc., for the treatment and disposal of the liquid wastes.

Airborne wastes.—Airborne wastes arising from grinding operations, vapor producing processes and the like are discharged to the atmosphere after passing through roughing filters to remove coarse particles and then through so-called absolute filters. These latter filters remove particulate matter in the gases down to 0.3 microns in size or lower. The radioactivity is almost entirely in this particulate matter. Sampling pumps are attached before and after these filters to impinge any radioactive material on discs of filter paper, which are then examined for radioactivity in the laboratory. This serves as a check on the efficiency of the filters and gives assurance that no radioactivity is discharged to the atmosphere above a permissible level. Another indication of the need for changing filters is an excessive pressure drop across the filters. This is done with pressure gages attached to the exhaust ducts ahead of and following the filters. As in the case of liquid discharges, the companies using these filters keep records of the activities found. In addition, wherever there is need, air samples for radioactivity are obtained at various locations both on and off the plant site as a check on the atmosphere in the general environment. The activities in the atmosphere vary from time to time as a result of weather conditions, bomb tests and other factors. In no cases to date have any activities higher than average been traceable to the industrial operations of the concern involved. These air samples are collected by means of a portable vaccuum pump impinging a known volume of air onto a filter mat or by means of exposed sticky paper which collects the dust in the atmosphere. Filter papers and sticky papers may be counted for radioactivity directly in radiation detection instruments or the papers may be burned to an ash and the ash examined for radioactivity.

Solid wastes.—Radioactive solids consist largely of machine filings, paper towels used in laboratories, discarded absolute filters, wiping cloths, animal wastes and the like. In most cases these solids have a very low order of radioactivity. Many are actually uncontaminated but are considered as contaminated since they were used in an area where radiocative materials are handled.

Many solid wastes are placed in steel drums, surrounded in some cases on the inside of the drum with an annular shell of concrete, tightly covered, and appropriately labeled as to the nature of the material and its activity. These drums are stored by the facility in a segregated storage area and periodically shipped out of the State by a carrier. The disposal area may be to an installation of the U.S. Atomic Energy Commission where a controlled burial ground is maintained with due regard for containment of the wastes to prevent ground or surface water contamination. Disposal of these wastes in selected regions of the Atlantic Ocean is also currently being practiced.

In some cases, low-level solid wastes may be incinerated in properly designed incinerators without hazard to the general environment. In this case the incinerator stack or chimney is monitored, and records of the activity of the discharge are kept. A recent amendment to the AEC regulations requires approval of all proposals for incineration by this agency as well as by this department.

BURIAL OF RADIOACTIVE WASTES

Sanitary code regulation 287 states that no radioactive waste may be disposed of by dumping or burial in Connecticut, except in areas approved by the department for that purpose. To date no burial sites have been approved. It is our present feeling that burial is best done at national burial grounds under the control of the AEC. On private land, ownership may change with resulting possible hazard from excavations, etc.

GENERAL SUPERVISION OF RADIOLOGICAL INSTALLATIONS

Before any facilities for the disposal of radioactive materials can be constructed in Connecticut, plans and specifications together with the nature and amount of radioactive waste, must be submitted to and approved by the State department of health. Environmental control facilities, including devices for air and liquid monitoring, continuous sampling, warning devices and records of levels of radioactivity found, may be required by the department. Furthermore, all composite samples must be available to the department for examination upon request. Also, of course, requirements of the Atomic Energy Commission must be met.

Such supervisory control of radioactive wastes as outlined above requires conferences with industrial and other users of radioactive materials and the setting of effluent standards for control of the radioactivity to the uncontrolled environment.

ENVIRONMENTAL SAMPLING A KEY TO SAFE OPERATIONS

In order to determine that safe levels are not being exceeded, environmental sampling is an important part of the department's work in this field. It is not enough to check plant operations, review plant records and check samples of plant effluents for radioactivity. Off-site sampling is not only assurance of safe levels of radioactivity in the environment from known discharges, but it furnishes valuable background information. In fact, the department started sampling of rivers, sea water, shellfish, raw sewage, and bottom muds before any major radiological installations were operating in Connecticut. Our river-sampling program is also being done on an interstate basis so that, for example, the radioactivity of the water in the Connecticut River is known at stations in Massachusetts, as well as in Connecticut. This checking of the levels of activity in environmental waters, shellfish, etc., thus furnishes a baseline of values for comparison with levels recorded in later years. The department has also made or cooperated in making air-sampling surveys at various locations in the State.

One air-sampling station in Hartford is operated continuously. Our air-sampling program will be expanded further in the future.

The inspection of uses of radioactive materials in industry and hospitals is now underway. This program has been delayed because of lack of trained personnel and the knowledge that in most cases disposal practices are undoubtedly safe under present conditions. However, as radioisotopes are used in greater quantities by these users in the future, the safety of sewers, sewage treatment plants, and the sludge produced by such plants (when used in the soil for fertilizer) will require more detailed investigation by the department.

TESTING METHODS

The methods of testing for radioactivity are many and in some cases quite complicated. It is not the intent of this article to describe these methods. Our bureau of laboratories is equipped to determine alpha, beta, and gamma radiations in minute as well as large quanties in samples of air or water. Both portable and laboratory equipment are available. Samples examined by private laboratories have been checked for radiation levels by our laboratories well within the usual limits of expected error. The department plans to expand its radiation-detection equipment and trained personnel to meet the growing needs in this field as they arise.

PROBLEMS OF RADIOACTIVE WASTE DISPOSAL IN NEW MEXICO

By

Dr. S. J. Leland, Director, New Mexico Dept.
of Public Health

During the post-war uranium development program sponsored by the Atomic Energy Commission, contracts were made between the Commission and mining companies, authorising the construction of mills, the purchase and development of ore bodies; and in fact, there was a great deal of hurry and haste about the whole situation. This department was never contacted in any way, which we of course quite well understood at the time, as secrecy was indicated and was being maintained. All we knew was what other people knew by reading the newspapers, that at a certain location near Grants, New Mexico there was a uranium mill. This mill was in operation for around one and one-half years, when as a result of a water sample picked up, I believe, by the U. S. Geological Survey Office who in turn reported to the State Engineer, and again who in turn brought the matter to our attention; we found that this mill was using the nitrate process for processing uranium ore.

The discharge from a combined operation was around 2,000 gallons per minute, and the tailings pond had a nitrate content of somewhere from 600 to 1200 ppm. Needless to say, the immediate underground water strata was saturated. We immediately instituted a program of sampling of water wells that we could locate adjacent to the plant, or where we thought they would be in the flow line of the underground water table.

The management of this mill came to Santa Fe so that we might all have a conference, at which time we discussed with them what could happen when high nitrate contents occurred in potential drinking water supplies. The problem had gone on so long that of course we had no clear-cut way of knowing just where the nitrate was which had accumulated in the underground water table over this period of one and one-half years or more. The company of course

looked into the matter, and I believe I am safe in saying that their own technological department indicated that there was indeed a problem, at least a potential one. They instituted a pilot plant study that they might be able to consider using a sodium chloride process.

The program I mentioned above, of sampling of water wells, began to pay off. Gradually the nitrate content began to build up in these samples as the wave moved underground. In fact, we were able to point out to this company that the domestic water wells on their own property should be considered seriously from the standpoint of continued domestic use. By that time the nitrate content had gone up well over 60 ppm in their domestic water wells.

The company in the meantime had established its own laboratory procedures and were also checking. They were of course convinced by this time that the problem was a very real one. They asked for another conference, at which time they asked if we would cooperate and work with them; to which we agreed, and they stated their intention then and there of going over to the chloride process, which they did at a cost which they reported to us at around one-half million dollars.

In talking with the superintendent of this mill, we asked him how they could have gone ahead using the process involving such high quantities of nitrate, knowing they would be discharging this tremendous quantity of waste into their tailings pond day after day and year after year. I thought his answer which was quite frank, was to the point. He simply stated that - "we never thought of that". The AEC and their company representatives were all simply very happy to have a mill constructed and in production.

Certainly, at that time, getting the ore out was the biggest problem. Today, as a result of uranium milling surplus, a problem with which the AEC is now confronted, I think we should take a closer look at the whole uranium and milling picture. The big mistake in the above-described example is in not having had the public health viewpoint represented anywhere in the planning or design for this facility. Public health, to a great extent, is still preventive medicine and anyone engaged in public health work would have realized the need for investigating further before adopting a process involving high concentrations of nitrate which would have to eventually find their way into an underground water strata.

As a result of the incident, although we are extremely short-handed and are not at all well equipped financially to really get into this picture, we realized that we must, even at this late stage of the game. As a result, we contacted every uranium mine and mill in the State. Most of them fortunately were in the pre-planning stage. They have cooperated wonderfully, explaining their process, letting us go over their plans, etc. We are doing this as a protection for the people of New Mexico. Yet everyone of them has a contract with the AEC which in no way recognizes either the authority or responsibility of the State of New Mexico insofar as the Department of Public Health is concerned.

If it were not for the assistance we have been able to render to these mines and mills, which has in turn made them glad to avail themselves of our services, there could be some question as to the legality of our insisting upon certain recommendations when they have a license from the AEC. Many of these companies are using various chemical processes for the treatment of uranium ore. This has led to the need for consideration of evaporation ponds inasmuch as most of these mills will not be discharging into any river or to surface water supplies. We also enjoy their confidence, they make reports to us and we carry on joint well sampling programs.

Were we to allow them all to simply leach their wastes, again we might make an already hard underground water impossible for use for domestic purposes. The preliminary planning we have been doing will to a great extent solve some of our problems. However, I believe it would be only appropriate that the AEC in negotiating new contracts or re-negotiating old contracts, would formalize the situation by making it a contract requirement that approval of the Health Department be obtained on all final plans and specifications, both as to domestic water supplies, sanitary sewage disposal and industrial waste disposal.

A second example of the type of cooperation that we really need to handle the problems of this new industry is provided by the installation of a uranium mill which is in Colorado, located near Durango. The effluent from this mill went into a tailings pond which had practically no capacity left. The site is in a canyon and the pond is in fairly close proximity to the river. There are two or more waste lines from the tailings pond directly into the river, and since there is no particular market for radium it is not recovered and is therefore discharged in the tailings pond, and of course some of it goes on through and into the river.

We have two cities located downstream some thirty to forty miles, both of which obtain their drinking water from the river. Preliminary sampling of the river above the discharge from this plant and below the discharge, indicates that there is a build-up of radioactivity and a significant increase in radium. Needless to say, we are quite concerned. We, therefore, made a formal request to the Public Health Service, Department of Health, Education, and Welfare, based on Public Law 660, asking for a hearing to be held with a view to investigating this situation. Public Health Service has already held the hearing with representatives from Colorado, New Mexico, Utah, Arizona, the AEC, and the company itself all present.

As a result, the Colorado and New Mexico Departments of Public Health cooperated with the U. S. Public Health Service in conducting a study of pollution in the Animas River this past summer. We understand that the report will probably be released this Spring by the Public Health Service, and it will of course point out any existing problems including those relating to uranium ore processing.

We can well understand that the AEC, by virtue of the nature of its organization, is the best equipped to handle research, production and development, and in the end application from a governmental standpoint. However, we believe the very nature of the AEC which is to concentrate on production, research, development and application, relegates the philosophy of public health protection to a secondary place. In other words, they are not always compatible to objective planning. It would seem, therefore, that it is only appropriate that the National health agency itself should supplement the AEC's activities by providing necessary information and data designed to properly protect public health.

Historically the Federal Public Health Service has carried out this role in excellent fashion. They are well attuned to the needs for protecting man's environment. They have established organizations including administrative and research laboratories. They carry on their programs, for the most part, as a result of good working relationships with the states and territories. Consequently, there would be no duplication on the part of another agency; it would simply be utilizing the best abilities and resources available to the country from the health protection standpoint.

Speaking for our own State, we have benefited greatly by virtue of working with Public Health Service, and should they be given the role of administering a health protection program involving radiological health, we would feel it would be most appropriate; for in the end we speak the same language. Certainly, in planning any special program it would be essential to have the utmost cooperation and to provide for exchange of information between the AEC and Public Health Service so that Public Health Service in turn could make available to the States the information that might be necessary that we might all work together.

The AEC should certainly benefit inasmuch as they would be relieved of the responsibility for which, again historically speaking, they were not particularly organized. They could then carry on their more basic objectives of further research, development and application, letting the aspects of health protection as carried out by Public Health Service, supplement these purposes.

It is our understanding that some consideration of this pattern, or a similar pattern, is under consideration at the present time. However, we understand that military establishments would be made an exception. Certainly we do not have any great interest in forcing entry or in regulating a military establishment. We have worked with many of them on a consultation basis as a cooperative effort, recognizing however that responsibility for the sanitation and health of such an establishment is primarily a matter of Federal concern. However, I believe that radiological health brings about a little different problem, somewhat similar to a policy we have here relative to, let us say, water and sewage facilities on a military reservation. As long as the water supply is self-contained on a military reservation and is maintained by the military for the protection of their own people, I do not see where we have any direct responsibility. However, if the military establishment is discharging sewage which might have an affect on our civilian population or on property adjacent to the reservation where it could have an undue affect on state-supervised areas; then I feel we do have the right to call it to the attention of the military.

I think that radiological health falls into this same category, inasmuch as they could be discharging waste products into our streams, or again, underground, to the detriment of the State, such as I pointed out that occured in the uranium mill example. If the AEC does not wish us in the states to handle this directly, we would be quite willing to abide by the results of the Public Health Service investigations, just so we knew that the matter was being handled by an agency interested in health protection.

Another problem relates to isotope users. We have neither the funds nor a sufficiency of trained technical personnel to actually handle the isotope program. We asked AEC to be notified of isotope users in the State. They were very obliging and we get copies telling us of companies in various states in the Union who have been given a permit to use isotopes in New Mexico; but about all we can

hope to do is write to these companies and ask them where they intend to store the isotopes, when if ever do they plan on using it in New Mexico, how, and why, etc. At the present time we have a radiation protection bill in our Legislature which, if passed, will require registration and will therefore help us considerably.

Again, it is an area where if a health protection agency were handling it on a Federal level, we would have more important information and would, we believe, be able to provide certain minimum requirements as a matter of controlling interstate traffic until certain state requirements were complied with.

In this connection, we all want the AEC to move forward, and yet, as we have pointed out, we question whether this can be done on a nation-wide basis as efficiently as if Public Health Service were in the picture and had been over a period of years.

These matters also point up the shortage of trained technical personnel to administer such programs as uranium mining and milling, and especially supervision of the use of radioactive isotopes. If Public Health Service were involved in such planning, it would appear to me to be a natural adjunct for them to encourage colleges and universities to further develop curriculum in their public health schools so that we may within a short period of time be able to add on to the Department of Public Health staffs in the states, trained people. Effective planning and coordination would, again, we believe, help relieve AEC of some of the implied responsibilities in this direction, and make them more specific in terms of basic public health procedure and progress.

I believe I have covered about all of the points which we have had in mind, and I am sure you can realize that as a result of the pressure on us to solve and work with some of the problems which have been created as a result of the rapid development and expansion of uranium mining and milling programs, we have had ample opportunity to thoroughly consider what has happened and to some extent to justify our viewpoint of the direction we hope future planning will take. I wish to re-emphasize what I have pointed out; that this is in no way intended as a criticism of instances which have taken place because of the need for expediency in the National interest. We simply hope that these lessons of the past will provide a more suitable key for the future so that by effective cooperation between the AEC, the Public Health Service and the State Health Departments, we may all continue to expand in our respective fields to permit further developments in the field of atomic energy, and yet at the same time insure effective public health protection.

STATE REGULATION OF RADIOACTIVE WASTES

By

Daniel E. Lynch, Assistant Sanitary Engineer, Ohio Dept. of Health.

Born May 23, 1905, in New York City. Educated at Harvard University (S. B., Chemistry) and New York University (Sanitary Engineering, no degree).

Work history: Industrial chemist, private industry, 1927 to 1936 (Pyridium Corporation and National Aniline and Chemical Company). Sanitary Chemist, city of New York, 1936 to 1942 (sewage treatment). During military service, 1942 to 1946, was classified as waterworks engineer and worked on water supply problems. As sanitary engineer was employed on water and waste problems by the U. S. Air Force (1946 to 1948) and on industrial wastes, including radioactive wastes, by the U. S. Atomic Energy Commission (1948 to 1956). In private business 1956 to 1957. Technical specialist on radioactive wastes with the Ohio Department of Health since then. Present title: Assistant Sanitary Engineer.

1. Ohio laws and regulations

At the present time there are no state laws or regulations in Ohio dealing specifically with radioactive wastes.

The Ohio Department of Health has statutory authority to regulate the disposal of wastes to waters of the state. This authority applies without distinction as to whether the wastes are radioactive or not. It depends on two provisions of law, one requiring the treatment of wastes by means of facilities for which plans have been approved by the department, the other requiring a permit from the Water Pollution Control Board, organized within the department, before wastes may be discharged to the waters of the state.

The Division of Sanitary Engineering of the department (a) reviews plans of proposed wastes treatment works, making recommendations to the Director of Health with respect to approval and (b) reviews applications for permits to discharge sewage and industrial wastes, recommending to the Water Pollution Control Board conditions and time intervals of issuance or renewal. Expired permits are renewed if the permittee has complied with conditions previously imposed. Otherwise the Board has authority to require corrective measures.

There are no statewide effluent standards for wastes which may be discharged to streams. Water quality objectives for sections of particular streams may take the form of permissible concentrations of contaminants or of required degrees of treatment of the wastes. In the case of organic pollution a minimum degree of treatment is as a rule required of municipalities and industries on a particular section of a particular stream. The degree of treatment necessary depends on the assimilating capacity and normal uses of the stream and on the pollution load. In the case of inorganic or toxic chemicals a permissible concentration may be established in the stream and this too depends on the normal stream use, in particular on whether the water is used for drinking.

However, the State Department of Health has not established any permissible levels for radioactive materials. The federal standards have so far seemed to be adequate and we expect plants and institutions having radioactive wastes, which have so far all been Atomic Energy Commission plants or licensees, to comply with the federal regulations.

However, the fact that an industry turns out an effluent which meets the federal requirements is not completely reassuring in itself. In general we require of industry that settleable solids in the waste effluent be kept to

a minimum and we are gratified when plants discharging radioactive wastes comply with this rule because it tends to avoid the accumulation of radioactive materials in the bottom mud.

There is a subtle difficulty in applying the federal standards. The permissible levels vary over a wide range depending on which radioisotope is involved. To determine from analysis of stream samples whether the standards are being met it would be necessary to identify the isotopes present and the quantity of each. This is a costly procedure if it is done on a scale adequate to the purpose. In our stream analyses we have not gone so far. We measure the activity and if it is higher than the permissible level for unknown isotopes we try to obtain a rough estimate of the half life or the decay curve, understanding that the materials with the shortest half lives have, as a rule, relatively high permissible levels.

We are aided in overcoming this difficulty by information obtained from plant managements during the inspection of their plants or from their routine reports. They know the nature of their waste radioactive materials and if they pass this information on to us we can be assured that a contaminant which exceeds the permissible level for unknown isotopes is nevertheless, because of its nature, safe and in compliance with regulations. This dependence on plant management is not completely satisfactory, however, and we are studying ways to improve our inspections and procedures of stream sampling and analysis.

There are exceptions to the rule requiring permits from the Water Pollution Control Board. If an industry has a contract with a municipality to discharge its wastes to a municipal sewer, a permit is not required. In such cases our control is indirect, depending on the fact that the municipality must have a permit to discharge its sewage to the stream. We receive no routine reports from the industry. We could, if necessary, investigate the radioactivity of the municipal sewage effluent but we have not done so, believing it to be inconsequential from our knowledge of the contributing industries.

2. Wastes from Atomic Energy Commission plants

The efforts of the state and the federal agencies in controlling stream pollution cannot be independent because ways must be found to apportion the receiving capacity of the stream equitably among the municipalities and industry, federal and private. For the pollution abatement program to work it has been necessary for the federal agencies to fit themselves into the state program. They have had to overcome two difficulties in order to achieve the necessary cooperation.

One of the difficulties is security. To overcome this the Atomic Energy Commission obtained "Q" clearances for the chief sanitary engineer and two other engineers of the State Department of Health, so that they might exhibit their wastes treatment measures to these engineers and discuss the associated problems with them. Also the department has obtained an access permit. However, the information obtainable under this permit is expected to be general in nature and not the specific information needed to evaluate the waste disposal problems at particular Atomic Energy Commission plants in Ohio.

The other difficulty is the matter of state versus federal jurisdiction or powers. To deal with this problem, the Atomic Energy Commission attaches to their cooperation reservations to the effect that their activities are not subject to regulation and control by state and local agencies where this would impede, burden or otherwise interfere with the discharge of the Atomic Energy Commission's functions and responsibilities under the Atomic Energy Act of 1954. Where conformity with state and local laws and regulations appears to be of mutual advantage to the Atomic Energy Commission and to the agencies concerned and where such conformity can be achieved without burden on federal funds or activities they are agreeable to voluntary conformance as a matter of comity.

We, for our part, have no desire or need to impede their activities but on the contrary we wish to help them whenever possible because of the importance to the nation of their work. Consequently, our relations have been harmonious. However, there seems to be cause for uneasiness in the reservation that conformity must be achieved without "burden on federal funds." Does this mean that measures to control stream pollution must be free of cost? If so, this seems unrealistic.

The fact is, however, that the Atomic Energy Commission does provide and operate facilities for wastes treatment and, although there have been some temporary problems, the control measures have been effective on the whole.

The managements of Atomic Energy Commission plants have been inhibited in differing degrees by the difficulties just mentioned. Some plants have cooperated fully to the extent of submitting plans of their proposed treatment works for review by our engineers, obtaining permits from the Water Pollution Control Board and sending us routine reports. This has at times served to prevent unjustified public anxiety because when people have believed themselves adversely affected by wastes from the plants, the knolwedge of the problem possessed by our engineers has enabled us to provide reassurance.

In the cases of other plants we have had little information. However, they have recently begun to furnish us with data. One reason is that some information previously classified can now be declassified. While we did not have complete information about these plants in the past, neither did we have cause to believe that they were contaminating the stream beyond the permissible limits. Our stream samples did not reveal any contamination. Our engineers had seen their wastes treatment facilities and, in the main, they were adequate.

3. Wastes from Atomic Energy Commission licensees

Where the licensee is a federal agency the problems are not essentially different than in the case of the Atomic Energy Commission.

Licensees in general have non-radioactive as well as radioactive wastes. Like industries outside of atomic energy they apply for Water Pollution Control Board permits and they do not usually attach qualifying reservations to their applications. There is, however, a reservation in all applications, printed on the forms, to the effect that, in applying for a permit, the applicant does not thereby waive any rights.

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4. Air-borne wastes

The responsibilities of the Department of Health relating to air-borne wastes as specified by a state law are carried out by its Division of Industrial Hygiene. The power to control atmospheric pollution outside of industrial plants rests with local government. The Division of Industrial Hygiene has, therefore, to rely on education and counselling rather than direct control regulations to minimize atmospheric pollution. The responsibility of the Ohio Department of Health is for research, education and a state laboratory for air pollution.

5. Interests of other agencies in radioactive wastes

The State Department of Natural Resources, the State Coordinator of Atomic Development Activities, some local governments and the Ohio River Valley Water Sanitation Commission are all concerned with the problem of water pollution by radioactive wastes. The interest of several agencies has not resulted in a multiplicity of regulations.

The law setting up the office of Coordinator of Atomic Development Activities regulates industry to the extent of requring persons working with nuclear or by-product material or related facilities to obtain whatever license may be required by the Atomic Energy Act of 1954.

The State Department of Natural Resources is interested in the protection of fish and wildlife and it has complained to the Department of Health in cases of wastes injurious to fish but it leaves the control of such matters by regulation to the Department of Health. The Department of Natural Resources may, however, assess damages for fish killed. It may also withhold its approval of the discharge of wastes to underground strata if such discharge threatens to damage mineral resources.

A municipality has, of course, the right to prescribe conditions under which industrial wastes may be discharged to sewers. In such cases there is no overlapping of authority because no state permit is required and regulation is left to the municipality.

Ohio, as a signatory state of the Ohio River Valley Water Sanitation Compact, has a hand in formulating the policies and regulations of the Ohio River Valley Water Sanitation Commission, which functions as an agency for coordinating the water pollution abatement policies and programs of the eight signatory states. The result is to avoid conflicting regulations and to harmonize the policies of the states.

6. Environmental contamination by accidental slug discharges

A usual condition attached to wastes disposal permits is that management will notify the Department of Health promptly in the event of any accidental slug discharge. It is sometimes necessary for the department in turn to warn the operators of downstream water supply systems.

This reliance on notification by industry is not completely safe. Sometimes temporarily high pollution is first revealed by a change in the appearance of the stream or the death of fish.

In the usual case the trouble is corrected promptly by the industry concerned. The Water Pollution Control Board has the power, in an emergency, to order the pollution stopped but this emergency power has never been used. (When there is no emergency the industry has the right to have a hearing and a showing that a practical method is available for treating wastes.)

The nature of radioactivity is such that dangerous quantities of it may not reveal their presence in the usual ways, such as by killing fish. Also, and especially in the case of reactor fission products, very dangerous quantities may be present in small volume. Pollution by radioactive materials in transit as well as from plants and reactors is possible. For these reasons the growth of the atomic energy industry seems likely to intensify the problem of dealing with emergencies. To cope with it, it seems necessary to improve the inspection program of the Department of Health and possibly to make some change in the emergency procedures which now have the weakness that power is vested in a board.

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PENNSYLVANIA'S ROLE IN REGULATING THE DISPOSAL OF RADIOACTIVE WASTES

By

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Graduated from Pennsylvania State University in 1939 with a Bachelor of Science in Sanitary Engineering.

Received a year's fellowship in public health with the W. K. Kellogg Foundation in Battle Creek, Michigan.

Public Health Engineer with two County Departments of Health in Michigan during the period 1940-43.

Director of the Division of Public Health Engineering with the Peoria, Illinois, Department of Health until 1949. During that time obtained a Master of Public Health degree from Columbia University.

Associated with the U. S. Public Health Service during the period of 1949-51.

Director of Professional Training with the Pennsylvania Department of Health 1951-54.

Accepted present position as Director, Bureau of Environmental Health, in 1954.

1. Development of the Radiation Control Program

Before describing the present program and the future plans of the Department in the field of radiation protection, it might be best to indicate briefly the organizational structure under which it operates. The Pennsylvania Department of Health is divided into five major units - four Bureaus and the Office of the Deputy Secretary of Health. One of these major units is the Bureau of Environmental Health in which there are four Divisions - Sanitary Engineering, Occupational Health, Sanitation, and Environmental Safety. As indicated by the titles, the activities of these Divisions encompass all of the programs concerned primarily with the public health aspects of the environment. Because Pennsylvania has only recently been able to establish county health departments, public health in the Commonwealth has necessarily been administered largely by a rather extensive staff in the State Health Department. The Bureau of Environmental Health alone has more than 300 professional and technical positions, and these staff members carry out their activities from seven Regional offices as well as from the central headquarters in Harrisburg. With the exception of the Philadelphia City Health Department, the Allegheny County Health Department, and three other county health departments, there are few official agencies providing professional public health

services at the local level. Even in these established local departments, a limited number of trained personnel were available with which to develop a radiological health program. This, then, was the situation when the State Health Department decided to extend its activities in the field of radiation protection.

As perhaps other state and local health departments have done, or are now doing, the first step seemed to be to take stock of present resources and to determine additional needs. The Department was fortunate in having a number of industrial hygienists who had been receiving training in the field from the Atomic Energy Commission in the inspection of radioisotopes, and a competent staff of sanitary engineers who were well versed in the treatment of other types of industrial wastes. In addition, one or two of the supervisors in the Divisions of Occupational Health and Sanitary Engineering had received advanced training in radiological health. However, there was no legislation, other than our "general health law", which gave the Department specific authority to carry out a radiological health program. The equipment necessary for a radiation protection program was limited and the instruments available were sufficient only for radioisotope inspections. The problem, therefore, consisted of four main phases: training present staff, employing additional specialists, adopting appropriate regulations, and procuring the necessary equipment.

In providing training for present staff, the Department relied largely on the facilities available from the U.S. Public Health Service. As a result of the usual fine cooperation of this Federal agency, 93 professional and technical staff members have attended advanced courses conducted by the staff of the Robert A. Taft Sanitary Engineering Center

of the Public Health Service in Cincinnati. In addition, two of the staff have completed an academic year of graduate study at the University of Pittsburgh. The established local departments of health were offered the opportunity of sending representatives to the basic courses held in the State and six of their staff members attended. The Department is now conducting its own training courses in Radiological Health.

In addition to training of present staff, it has been necessary for the Department to employ personnel already qualified in the field of radiological health. A health physicist, who has worked previously with the Atomic Energy Commission and the Argonne National Laboratory, was appointed as Chief of the Radiological Health Section of the Division of Occupational Health. His duties include technical consultation to the Division of Sanitary Engineering on radioactive waste disposal problems as well as the normal radiation protection activities of his own Division. As a means of providing additional qualified staff for the Division of Sanitary Engineering, a sanitary engineer has been employed who has received a Master's degree and extensive specialized training in the field of radioactive waste disposal.

The third phase in the development of a radiological health program was to adopt appropriate regulatory measures. As stated previously, since the Department had no specific authorizing legislation, regulations were adopted by the Advisory Health Board based on the broad powers of the Department "to protect the health of the citizens of the Commonwealth". These regulations are, in essence, the recommendations contained in Handbook 61 issued by the Bureau of Standards and the National Committee on Radiation Protection with the requirement that all sources of radiation must be registered with the Department. Since these regulations became effective

in October 1956, approximately 7,000 registrations have been recorded and the staff of the Division of Occupational Health is investigating these sources on a priority basis of public health import.

2. Control of Liquid Radioactive Wastes

(a) General Policy Development

When, in early 1954, it became certain that the first commercial power reactor was to be constructed in Pennsylvania, the State Department of Health and its water pollution control agency, the Sanitary Water Board, looked to their responsibilities. Despite the indecision at the time concerning the jurisdictions of the Atomic Energy Commission and state agencies, the State Health Department elected to apply its authority under its general health powers to the adoption of radiation protection regulations. In addition, the Sanitary Water Board classified radioactive liquid wastes as industrial wastes, thus requiring a permit for discharge of any such wastes to the waters of the Commonwealth.

In order to apply for such a permit, the operator submits to the appropriate regional sanitary engineer the completed application forms, a detailed report prepared by a registered engineer, and the final plans of the proposed waste treatment facilities. After review by the Department's field office, including the usual conferences with the consulting engineer regarding revisions necessary to comply with existing standards, the various documents are forwarded to the Central Office in Harrisburg. Here the report and plans are subject to final review by sanitary engineers in the Industrial Wastes Section of the Division of Sanitary Engineering. If everything is in order, a recommendation to this effect is submitted by the Division of Sanitary Engineering to the Sanitary Water Board at its regular monthly meeting and, if considered favorably by the Board, a permit is granted.

With the assistance of the Radiological Health Branch of the Public Health Service, the technical staff of the Bureau of Environmental Health developed the conditions under which liquid wastes from the nuclear reactor at Shippingport, Pennsylvania, could be discharged. As a result of the cooperation and competence of officials of the Duquesne Light Company and Westinghouse Electric Corporation, early agreement was reached on the radioactivity limits deemed necessary for the protection of the public health. The company, in its application report, had adhered to the maximum permissible concentrations recommended in Handbooks 52 and 61 of the Bureau of Standards and the requirements of the State Health Departments Radiation Protection Regulation. However, as indicated by the permit accompanying this statement, in the interest of public health protection, more stringent requirements were incorporated into this document than are recommended by national authorities.

(b) Technical Standards for Discharges

The accepted standard applied to the discharge of liquid wastes to streams utilized for public water supplies is that the radioactivity for unknown isotopes shall not exceed an annual average of 1×10^{-8} microcuries per milliliter above natural background radioactivity at the next point of use downstream. Where the isotopes are known and are readily measurable, the concentration of the discharge is limited to one-tenth of the sum of the apportioned maximum permissible concentrations. The maximum permissible concentrations are apportioned in accordance with the amount of each isotope present. To provide extra protection for the waters traversing Pennsylvania and to retain a portion of the stream flows for the discharges from future nuclear facilities, several safety factors were added to these standards.

As an example, the sampling point for Shippingport wastes is in the plant's effluent channel containing the condenser cooling water. This location results in an extra safety factor of more than 100 since the

maximum amount of condenser cooling water is less than 1/100 of the mean flow of the Ohio River. Another appreciable factor of safety is that the limits of radioactivity apply at any time, rather than to the average concentration over an interval of one year.

The discharge is normally limited in quantity to a fraction of the "ordinary low flow" of the receiving stream. The ordinary low flow is the average of the 90 lowest daily mean flows of an approximately normal year. The fraction of the ordinary low flow is determined by considering (1) present and proposed use of the stream particularly where public water supplies and bathing places are involved, (2) present and future use of the stream for radioactive waste discharges, and (3) considerations of safety dictated by the fact that our knowledge in relation to the uptake of radioactivity by stream bed, bottom muds, and stream biota is limited at this time.

(c) Application of Policy

These conservative requirements have been incorporated in the permits issued to six other nuclear facilities of various types and will be applied to several applications now under consideration.

In considering the application of the Duquesne Light Company, one of the initial counterproposals of the Pennsylvania Department of Health was that the company reduce substantially its request for an emergency discharge of 700 curies of tritium in one day should an accident occur in any of the coolant loops. Although this amount of tritium was below the maximum permitted by accepted standards for an average concentration over an entire year, the company agreed to withdraw this proposal and limit the maximum discharge of tritium during any one day to less than 1 percent of the maximum allowable concentration. This agreement is consistent with the objective of the Department of Health and its Sanitary Water Board to produce and discharge the least amount of radioactivity practicable.

Recent analyses of waste discharges from the Shippingport plant indicate that it will be possible to conform to the stringent standards for fission products as well as for tritium.

During 1956 and 1957 the Westinghouse Electric Corporation conducted, under the sponsorship of the Atomic Energy Commission, a site-monitoring program in the vicinity of the Shippingport plant. The purposes of the pre-operational phase of this program were to determine the types and amounts of radioactive materials which occur in the environment around the reactor plant, and to determine the variations in the amounts of these materials over a period of approximately 1½ years prior to operation. Analyses were made on (a) soil in the general vicinity of the plant, (b) Ohio River water above and below the site, (c) well water within a one-mile radius, (d) vegetation in this general area, and (e) air in the general area.

Although the Department of Health accepted the reports of Westinghouse's study and assisted in some of the sampling, it decided to initiate further studies in the area in order to encompass all phases of the environment subject to possible contamination by radioactivity. Through the efforts of the Department's public health veterinarian, specimens of animal life and milk products have been collected and analyzed for radiation levels, both in the general area of the plant and in a control area. Using Public Health Service program grant funds, the Department has contracted with the University of Pittsburgh to determine the radioactivity levels of all types of aquatic life in the Ohio River above and below the plant site. Since both the Department of Health and the Duquesne Light Company are continuing the site-monitoring programs on a post-operational basis, data will be available on all of the environmental aspects which could be affected by nuclear facilities in this area.

(d) Summary

Public health authorities in Pennsylvania are administering a program of radioactive liquid waste control in the following manner:

1. Radioactive liquid wastes have been classified as industrial wastes and thus are subject to a permit from the Sanitary Water Board.

2. Since the treatment processes employed at such installations have not been subject to full-scale operation experience, the permits are granted on an experimental basis.

3. For the purpose of insuring protection of the public health and the retention of stream volumes for future discharges, the levels of radioactivity in liquid wastes must conform to more stringent standards than those generally accepted.

4. The conditions of the permit, including the maximum allowable concentrations, are subject to revision if altered conditions or the advance of science and technology so indicate.

5. The discharge of radioactivity shall be kept at the most practicable minimum, regardless of maximum amounts permissible.

6. Adequate analyses and operational reports must be submitted to the Department of Health.

7. Environmental monitoring programs shall be continued and, if necessary, expanded.

8. Immediate notification of the Department is required in the event of accident or discharge in excess of tolerance.

3. Control of Airborne Radioactive Wastes

The Pennsylvania Department of Health is also concerned with the discharge of radioactive wastes into the air of the Commonwealth. To insure the safety of the air supply, concentration limits for airborne radioactive

material have been set in Pennsylvania's Radiation Protection Regulation 433. The maximum concentration levels adopted for airborne radioactive material are those which have been recommended by the National Committee on Radiation Protection in the handbooks of the National Bureau of Standards.

The Department's Division of Occupational Health has reviewed the air cleaning system designs and procedures of the Shippingport Atomic Power Station, the Curtiss-Wright facility at Quehanna, the Westinghouse facility at Waltz Mill, and several other nuclear facilities. Recommendations have been made, many of which have been incorporated into the design or procedures of the nuclear facilities.

4. Control of Solid Radioactive Wastes

While the Department's policy on the question of burial of radioactive wastes is by no means fully developed, there are certain aspects of this policy which are beginning to take shape.

(a) Low Level Wastes

These are wastes which meet the radioactivity levels of Part 20, Title 10 of the AEC regulations. Where the user can positively establish that waste material meets AEC Part 20 requirements, it would appear that these low-level wastes should be buried by the licensed user in accordance with State and AEC requirements. In cases where burial by license is not possible, shipment to an intermediate level burial site should be authorized.

(b) Intermediate Level Wastes

Because of the many factors which are still unknown about the disposal of solid radioactive wastes and their effect upon the environment, the Department looks with considerable disfavor upon the possibility of a number of privately-owned and -operated intermediate level disposal sites. Many of these materials will retain their radioactivity for hundreds of

years and more. Therefore, such disposal sites should be located on property owned by the State or Federal governments. The problems of supervising the operation and controls at a number of such commercial sites in order to be absolutely certain that no permanent hazard is being created to the general environment would be beyond the capacity of State or Federal agencies. The question of finding the most desirable geologic conditions is in itself complex, and the disposal site should be located where these conditions are ideal.

For these reasons it is believed that the burial of all low level wastes not buried on the property of the user and all intermediate level wastes be only at sites owned and operated by appropriate agencies of the State or Federal Government. It is also felt that these sites should be kept at the absolute minimum in numbers and be selected on the basis of protection of the public health and safety and economy of transportation.

(c) High Level Wastes

While there appears to be no clear definition at this time which would differentiate between intermediate and high level wastes, the likelihood exists that various types of wastes may not be considered safe for disposal at certain burial sites and must be taken to existing AEC facilities for storage or burial.

5. Federal - State Relationships

(a) Public Health Service

When subsequent to World War II problems of radiological health became of increasing public health importance, the Public Health Service initiated an active program of consultation and training in order to assist the States in the development of their own programs in this area. It is to a large extent due to this effort that the Pennsylvania Department of Health and other State Health Departments were able to train personnel

rapidly and enter into the more complex aspects of radioactive waste disposal technology such as those connected with the Shippingport power reactor.

(b) The Atomic Energy Commission

(1) Training

Assistance given the Department by the AEC has been limited to field training given to a small number of the staff by making joint inspections of licensees with AEC inspectors.

(2) Licensing & Inspections

The Department has made considerable effort during the past several years to establish a closer working relationship with the AEC in the following areas: (1) early notification from the Commission on applications or plans for nuclear facilities in Pennsylvania, and (2) a better coordination and elimination of duplication of effort in inspection activities. Unfortunately little progress has been made in either area. The Department, after specifically asking the General Manager of the Commission to advise it on proposed nuclear facilities in October of 1956, still finds itself in the position of having to read in the newspapers of specific proposals to locate a large nuclear reactor on one of its major waterways.

While the Commission's staff is admittedly limited, dual inspections of licenses in Pennsylvania have resulted in an unnecessary waste of effort. Meetings with the Commission staff in an effort to better coordinate the inspection activities of the two agencies have so far resulted only in failure to reach an agreement.

(3) Proposals for Legislation

The Pennsylvania Department of Health is particularly concerned with the following proposal to amend the Atomic Energy Act of 1954 recommended

by the Council of State Governments and endorsed by the Atomic Energy Commission.

PROPOSED AMENDMENT TO THE ATOMIC ENERGY ACT OF 1954

"Section 274 Cooperation with States - (a) The Commission is authorized to cooperate with any State or group of States in carrying out the Commission's responsibilities for protecting the health and safety of the public from radiation hazards incident to the processing and utilization of source, byproduct, and special nuclear material. To this end, the Commission is authorized to enter into agreements with any State or group of States to perform inspections or to provide such other services to the Commission as the Commission deems necessary. Further, the Commission is authorized to provide with or without charge training to employees of any State or group of States and such other services to any State or group of States as the Commission deems necessary.

(b) Nothing in this Act shall be deemed to prevent the States from adopting, inspecting against, and enforcing standards, not in conflict with those adopted by the Commission, for protecting the health and safety of the public from radiation hazards incident to the processing and utilization of source, byproduct, and special nuclear material, Provided, that this subsection shall not be deemed to authorize any State to exercise licensing responsibilities concerning those aspects of activities with regard to which the Commission has licensing responsibilities, and Provided further, that State radiation standards shall not apply to facilities operated by the Government or facilities operated under contract with and for the account of the Government. The Commission is authorized

to cooperate with the States in the development of such radiation standards.

(c) The Commission shall continually study, in consultation with the States, the desirability of recommending to Congress legislation which would further adjust Federal and State responsibilities in the radiation protection field."

This proposed amendment is excessively restrictive because it would deprive the States of their proper jurisdiction in the field of public health protection. It is unnecessary because it spells out areas of cooperation which, as has been stated by executive members of the Commission's staff, can be carried out under present legislation.

Paragraph (a) of the proposed Section 274 authorizes the Commission to seek the cooperation of the States in the field of atomic energy. It permits the Commission to use State assistance in carrying out its responsibilities and authorizes the Commission to provide training to State personnel.

While there is nothing objectionable in the language of this paragraph, it does touch upon the basic principle of where public health responsibilities should lie in the first place. The Atomic Energy Commission now, in fact, acts as a public health agency where it exercises its licensing functions with respect to non-federal installations. This is a responsibility that should be in the hands of the State and not of the Federal Government. The fact that this responsibility is being carried out by a Federal agency which is not a public health agency and which, as a matter of fact, has as its basic responsibility the promotion of the uses of ionizing radiation, presents that agency with a very serious conflict of interests.

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Paragraph (b) of the proposed Section 274 says that the States may adopt radiation standards not in conflict with those of the Commission, but it specifically prohibits licensing activities by the States in areas preempted by the Commission.

This provision virtually eliminates meaningful regulatory activity by the States in the control of radioactive wastes. It would appear to prohibit the Pennsylvania Department of Health from issuing Sanitary Water Board permits to establishments discharging radioactive wastes which are licensed by the AEC. This would mean that while the Department might have regulations concerning such matters, it could never as a State agency revoke the operating privilege from such establishments for failure to meet its regulations. This provision would for all practical purposes eliminate the present program of controlling radioactive wastes. The Department would have to rely upon the good will of the AEC to so do and this would not likely be forthcoming if its regulations and standards were more stringent than those of the AEC. It so happens that our requirements are more stringent in the case of liquid discharges, and in our opinion AEC's present requirements are inadequate in the area of solid wastes.

This paragraph also completely frees facilities operated by the government or by contractors for the account of the government from State regulations and standards. Since many of the important users of radioactive substances fall into this category, this would practically nullify the effect of any more stringent standards as a State may wish to establish.

It is particularly interesting to note in the "Analysis of the Proposed Amendment" submitted by the Commission to the Chairman of the Joint Committee the statement concerning subsection (b) that "A dual licensing system from the standpoint of radiation protection would be a totally unnecessary burden to impose on the emerging atomic energy industry." Here the conflict between the promotional responsibilities of the AEC and the traditional public health responsibilities of a State stands clearly

revealed. The protection of the State's public health by the State agency is considered an "unnecessary burden". The following paragraph of the "Analysis" covering Federal installations and contractors reiterates this by saying, "There does not seem to be any legitimate purpose served by subjecting such facilities and activities to State regulation." Is the protection of the public health by the State not a legitimate purpose? The Department has found in all of its contacts with the various producers of radioactive wastes and users of radiation that in spite of AEC regulatory activity, which is quite limited (perhaps due to budgetary reasons), much additional activity is needed by this Department in order to accomplish safe protection of the environment for the population of Pennsylvania.

While paragraph (c) of the proposed amendment does not appear to contain any controversial language as do paragraphs (a) and (b), it is apparent that Federal legislation is not necessary to authorize the usual consultations carried on between related state and federal agencies.

6. Summary

In summary, it is my opinion that the proposed amendment if passed would continue to advance a doctrine in Federal-State relationships in public health which is in essence new and should be questioned seriously. These are: (1) That public health responsibilities can be carried out by a federal agency that has as its primary objective activities which may be in serious conflict with public health objectives of state health agencies. (2) That the Federal government may if it wished preempt to itself certain regulatory activities and, in fact, prohibit the States from carrying them out on their own.

We have tried to summarize briefly the policies and activities of the Pennsylvania Department of Health in protecting the population of the

Commonwealth against the hazards of radioactive wastes. We have also taken this opportunity to express our concern about certain areas of existing Federal-State relationships and legislative proposals which have been made in the recent past.

We certainly appreciate the opportunity we have been given to present our opinions and suggestions to the Committee.

[From Public Health Reports, vol. 73, October 1958]

COMMONWEALTH OF PENNSYLVANIA,
DEPARTMENT OF HEALTH,
SANITARY WATER BOARD,
Harrisburg.

INDUSTRIAL WASTES PERMIT NO. 1832

The sanitary water board, which by virtue of the Act of April 9, 1929, Public Law 177, known as the Administrative Code of 1929, and the amendments thereto, and of the act of June 22, 1937, Public Law 1987, as amended by the act of May 8, 1945, Public Law 435, is empowered to exercise certain powers and perform certain duties "To preserve and improve the purity of the waters of the Commonwealth for the protection of public health, animal, and aquatic life, and for industrial consumption, and recreation;* * *", hereby issues this permit to the Duquesne Light Co., 435 Sixth Avenue, Pittsburgh, Pa., its successors or assigns, approving, subject to certain conditions, the proposed works for the treatment of wastes from the permittee's atomic (nuclear reactor steam turbine) powerplant located in Shippingport, Beaver County, Pa., with discharge of the treated effluent therefrom into a channel of the Ohio River between its left, or southern, bank and Phillis Island, about 11 miles below the confluence of the Beaver River, in response to an application, undated but attested, June 19, 1957.

This plant is designed for the production of 60 megawatts, i.e., 60,000 kilowatts of electrical energy during initial operation. Later, possibly after about a year, and when the present core has been replaced by a more powerful one, the plant is expected to reach a maximum rating up to 340 megawatts of heat and 100 megawatts gross electrical output.

This application requests approval of "the discharge to the Ohio River of an average of 12,000 gallons per day of waste water containing approximately 10 curies of tritium and 1,590 microcuries of other radioactive materials. This effluent consists, for the most part, of laundry and shower room wastes and neutralized laboratory wastes which are released to the condenser effluent stream at a controlled rate. The lesser portion of the discharge consists of reactor plant wastes. The system consists of gravity collection tanks; intermediate storage and decay tanks; processing by evaporator ion exchangers, gas stripper; followed by controlled discharge to the river. Radioactivity is measured at each stage of the process and before discharge." It is to be noted that the term "neutralization," as used above refers only to chemical neutralization.

The proposed plant and waste-treatment works will provide for batch treatment of all wastes. If in the opinion of the sanitary water board, any wastes are inadequately treated, facilities will be available for recycling such wastes through all or parts of the treatment process until the effluent is satisfactory for discharge to the waters of the Commonwealth when diluted with the normal volume of cooling water. The proposed works are described in some detail in an engineering report entitled "Duquesne Light Co.—Shippingport atomic power station—Shippingport Borough—Beaver County, Pa.—April 20, 1957" and are shown on 12 sketches and diagrams bound with the report and entitled and described as follows:

Artist's conception of the Shippingport atomic power station.

Figure 1. Duquesne Light Co.—Territory served and location of principal facilities—December 31, 1955—No. SP–507.

Figure 2. Shippingport power station—Duquesne Light Co.—Plan showing general arrangement.

Figure 3. (This is an isometric drawing, diagrammatic, showing the reactor and four main coolant loops.)

Figure 4. PWR reactor vessel.

Figure 5. (These are enlarged detail sketches of reactor core, seed and blanket assembly, fuel rods, etc.)

Figure 6. Seed assembly cross section.

Figure 7. PWR fuel rod exploded view.

Figure 8. Reactor and steam plant—Plan view.

Figure 9. Radioactive waste disposal system—Plot plan.

Figure 10. Radioactive waste disposal system (flow sheet).

Figure 11. Shippingport power station—Area survey stations. * * *

Also bound with the company's report are two tables, "Table I— Expected maximum steady-state activity for nonvolatile fission products in the PWR wastes—Duquesne Light Co.—Shippingport atomic power station" and "Table II—Activity discharged to river—Waste disposal system—Duquesne Light Co.—Shippingport atomic power station."

The report and plans were prepared by J. A. Tash, engineer, power stations department of the Duquesne Light Co. The report is signed by W. J. Lyman, a professional engineer, Pennsylvania Registry No. 5582, vice president, operations division, Duquesne Light Co., and stamped as received in the Pennsylvania Department of Health, Division of Sanitary Engineering, Region III, on June 21, 1957.

These plans are hereby approved subject, nevertheless, to the condition that the waste treatment plant to be constructed under said plans will produce an effluent satisfactory to the sanitary water board. By this approval, neither the board nor the Commonwealth of Pennsylvania assumes any responsibility for the feasibility of the plans or the efficiency of the operation of the plant to be constructed thereunder.

This permit is issued subject to the following special conditions:

A. The waste treatment facilities shall be constructed and ready for operation coincident with the start of power operation of the reactor.

B. Approval of plans refers to waste treatment and not structural stability, which is assumed to be sound and in accordance with good structural design. Failure, because of faulty structural design or poor construction, of the works herein approved will render this permit void.

C. Since the herein approved works employ principles not at present considered conventional, they must be regarded as experimental and the subsequent action of the sanitary water board will depend on actual performance in eliminating the objectionable characteristics of the waste waters as discharged from the works in question.

D. The discharge of untreated or improperly treated industrial wastes to the waters of the Commonwealth is contrary to the requirements of the sanitary water board. If, because of accidental breakdown of the treatment works or plant equipment or for any other reason, any such discharge should occur, then the operation of any process producing such discharge shall be discontinued until repairs to the treatment works or other satisfactory measures to prevent stream pollution shall have been completed.

E. The permittee is hereby directed to immediately notify the Pennsylvania Department of Health whenever there is a spill or an accidental discharge of radioactive material and shall advise that department promptly concerning the pertinent facts and probable danger. The permittee shall maintain rosters of Pennsylvania Department of Health personnel and of downstream users of river water who shall be notified. The necessary information for such rosters shall be furnished to the permittee by the department of health. In the event of any such accidental discharge, the department of health shall determine whether or not downstream users shall be notified, and by whom.

Moreover, the permittee is required to see to the training and supervision of all operating personnel, in order to prevent the discharge of such material, fluid or solid, to the waters of the Commonwealth or to the site, without adequate treatment.

F. All industrial wastes discharged to the portion of the Ohio River on which the permittee's plant is located shall meet at least the requirements of the sanitary water board for primary treatment. Primary treatment does not apply to the radioactive characteristics of the wastes.

The term "primary treatment," as here used, is such treatment of sewage as, in the opinion of the board, will remove practically all of the settleable solids; will remove at least 35 percent of the organic pollution load as measured by the biochemical oxygen demand test; will accomplish the removal of oils, greases, acids, alkalis, toxic putrescible, taste- and odor-producing substances, and other substances inimical to the public interest in the receiving stream; will provide effective disinfection to control disease-producing germs; will provide for satisfactory disposal of sludge; and will produce a final effluent that is suitable for discharge into the receiving stream. Primary treatment of industrial wastes, as here used, is treatment to a degree equivalent to that set forth herein for sewage.

Moreover, because of the radioisotopes which these wastes may carry, such wastes shall be substantially free of turbidity and suspended solids over and above the amounts of such characteristics in the intake water.

G. The treated radioactive liquid wastes as discharged to the Ohio River shall comply with the Pennsylvania Department of Health Radiation Protection Regulation 433 and any subsequent regulations of the department of health.

H. With respect to the amount of radioactivity released in the liquid wastes to the waters of the Commonwealth, this permit is issued subject to the following conditions: (1) That the average radioactivity, exclusive of tritium activity,

of these wastes over any consecutive 365-day period shall not exceed 1,590 microcuries per day, with the maximum discharge not exceeding 6,200 microcuries per day; (2) these wastes shall at no time carry more radioactivity, exclusive of tritium activity, than 10^{-5} microcuries per milliliter in excess of that of the plant intake water from the Ohio River; and (3) that the discharge of tritium in these wastes shall be not more than 10 curies per day averaged over any consecutive 365-day period, nor more than 50 curies per day maximum. Moreover, the company shall conduct all its pressurized water reactor operations so as to produce and discharge the least practicable amounts of radioactivity.

I. Although tritium has a short biological half-life (19 days) and a maximum permissible concentration (MPC) of 0.2 microcuries per ml. (according to Handbook 52 of the National Bureau of Standards) as compared with an MPC of 10^{-5} microcuries per milliliter for the general population for unidentified isotopes, its radiological half-life is long enough (4,600 days) to make its continued presence in the stream undesirable and possibly inimical to aquatic and other life. At the present time, it is reported, there are no practical means for its separation from a liquid. The permittee, however, shall continue to investigate and apply more effective means to remove this potential hazard as rapidly as such means are developed, or attempt to devise some other means or to attempt to find some other substance which will have advantages similar to that of lithium hydroxide without producing the present discharge of tritium. The attention of the permittee is directed to the possibility that tritium may prove objectionable as a constituent of water used for certain industrial processes.

J. The radioactive and other liquid wastes discharged to the effluent channel shall be well admixed with the cooling water so that the waste content of this channel shall be substantially uniform below the effluent weir or at the sampling rake.

K. The treated effluent shall be discharged to the river in a manner acceptable to the sanitary water board. If any structure is necessary to accomplish this, it shall be well protected against the effects of floodwaters, ice, and other hazards and the design of such structure shall be acceptable to the sanitary water board.

L. Provision shall be made for regulating the discharge of the treated effluent so that it shall be equally distributed over the longest practicable period, in order that advantage may be taken of maximum possible dilution by the receiving stream, and means to accomplish uniform 24-hour distribution shall be provided if in the opinion of the department of health this shall be found necessary.

M. The wastes after treatment and prior to discharge to the effluent channel shall contain no more than 0.05 parts per million of hexavalent chromium and 1.0 parts per million of trivalent chromium.

N. The permittee shall provide means for measuring the total volume as well as variations in the rate of discharge of all waste water. Equipment to automatically record this information shall be provided promptly if directed by the department of health.

O. Any solid waste material including radioactive material shall be so handled that a nuisance is not created, and shall be disposed of in a safe and sanitary manner to the satisfaction of the department of health and in accordance with the provisions of the Pennsylvania Department of Health Radiation Protection Regulation 433 and any subsequent regulations of the Pennsylvania Department of Health.

P. It is required that a sampling schedule be maintained and that records thereof be kept together with records of the operation of the waste disposal system, and that such data be submitted in reports to the department of health, covering such particular matters and at such intervals as the department may direct, beginning within 2 months after the initial operation of the plant. It is noted that the report submitted with the present application indicates that records will include:

1. Accumulation rate and activity for each class of waste by days.
2. Changes in activity of wastes during processing.
3. Volume and activity of waste discharged.
4. Time of day and duration of discharge with volume and activity automatically recorded.

The special nature of the wastes produced at the permittee's Shippingport plant may cause the sanitary water board to require additional sampling, analysis, and testing of the surface and underground waters in the vicinity, particularly of the Ohio River at points above and below the plant, in order to determine the effects of radioactivity on these waters.

The report submitted to the board by the permittee, in support of its permit application, indicates that such sampling is being conducted at present by or

under the sponsorship of the U.S. Atomic Energy Commission. If for any reason, however, the AEC does not continue this sampling, or if in the opinion of the sanitary water board additional data are needed, the permittee may be required to conduct such sampling and analysis as the board may direct.

Q. Acknowledgment is made of the company's study now in progress to determine temperatures and percentage of river volume that flows through a narrow river channel between Phillis Island and the mainland to determine the expected rise in river water temperature in this channel when the condenser cooling water is discharged to it. The permittee is hereby advised that the river water temperature rise is tentatively limited to 2° F. at points to be determined by the sanitary water board after the results of the thermal studies of the channel and of other data have been reviewed, and that if this limit cannot be maintained with the proposed method of discharge, then complete dispersal of the condenser effluent in the river, or other means for temperature control, may be necessary. The report on the river channel study shall be submitted in duplicate to the sanitary water board within 60 days of completion of the study which is expected to terminate in the last months of 1958, with progress reports on a quarterly basis.

R. The permittee shall submit to the sanitary water board a comprehensive report on the operation of the herein approved treatment works within 6 weeks after completion of the first half-year of operation, and within a similar period of time subsequent to any substantial change in the operating capacity of the plant or any other marked change in operation or waste treatment. The report shall include pertinent information as to waste volumes, radioactivity before and after waste treatment, the general adequacy of these works in treating all waste discharges from this establishment so as to meet the requirements of the sanitary water board for primary treatment, an overall estimate of the success achieved in (1) the reduction of the pollution carried to the stream and (2) in the continuous maintenance of a final liquid effluent meeting the requirements of the board as to uniform admixture with the cooling water.

S. If the effluent as produced by the waste treatment works herein approved shall in the opinion of the sanitary water board prove to be of quality unsatisfactory for discharge into the receiving stream, by reason of the creation of a public nuisance, or because of change in the character or volume of the wastes, or in the use or condition of the receiving stream, or for other reason; or because in the board's opinion such discharge is or may become inimical or injurious to the public health or to animal or aquatic life or to the use of the receiving body of water for domestic or industrial consumption or for recreation, then a higher degree of treatment (by means of additional plant units or otherwise) shall be provided. Plans for additional works shall be prepared promptly after notice from the board so to do, and after approval of the plans by the board, the additional treatment shall be provided and placed in operation within such time as the board shall require. No construction shall be undertaken without such approval.

T. This permit will be subject to review from time to time by the sanitary water board, and to change if so indicated by altered conditions or the advance of science and technology.

And this permit is further subject to the following numbered standard conditions of "Standard Conditions Relating to Industrial Wastes" effective January 1, 1941, attached hereto: 1, 2, 3, 6, 7, 13, 16, and 17.

[NOTE: These standard conditions require adherence to prior permits or orders, compliance with the approved construction plans and with the established effluent standards, adequate supervision during construction, notification of the department of health when construction is completed, proper maintenance of treatment facilities, and permission from Federal authorities for the installation of stream structures—EDITOR.]

This permit is issued in response to an application (No. 12234–IW) filed in the Harrisburg office of the Pennsylvania Department of Health on the 22d day of June A.D. 1957, and in accordance with the authorization given by the sanitary water board at its meeting on September 12, 1957.

SANITARY WATER BOARD
By: BERWYN F. MATTISON, M.D.,
Secretary of Health, Chairman.

Attest:

JOHN W. GITTINS,
Secretary.

HARRISBURG, PA., *November 1, 1957.*

Activities of Texas Agencies in Regulating Disposal of Radioactive Waste
by Henry A. Holle, Commissioner of Health, State of Texas Dept.of Health

SUMMARY

Up to January 1, 1959 no serious radioactive waste disposal problem has existed in Texas. The majority of such wastes enter our environment today via the public sewer. Although an analysis of this practice indicates that the present amount of radioactivity in sewage creates no hazard, increase in the application of radiation in all its facets may develop a problem. Background surveys are being conducted to determine the current concentrations of radioactivity in our air, milk and surface waters. These studies should be expanded to include underground waters, certain foods, crops and livestock. Only after establishing firm base lines will we be able to assess fully the impact of each new phase of this coming industry.

Many opportunities are arising regularly in this new field, e.g., organizations capable of safely handling and disposing of the radioactive waste products of the new era. Such organizations are visualized, as evidenced by the proposed issuance of an AEC license to the Industrial Waste Disposal Corporation of Houston, Texas, to dispose of radioactive wastes in the Gulf of Mexico. The Halliburton Oil Well Cementing Company, Duncan, Oklahoma, has consulted with us concerning the possibility of expanding their activities to include a nation-wide waste collection and disposal service. This is only the beginning. As these new problems arise in Texas men with technical ability and initiative will be employed or the State will lag behind others more progressive. Solutions must be found by which we will enhance the growth of this industry without jeopardizing the health or safety of Texas people.

Under the State Regulations on Radiation Exposure (Inclosure 1), waste products may be discharged to the air and waterways within specified limits. (See Section 14 of these Regulations.) Disposal by dumping or burial is also authorized in areas approved for that purpose by the Texas State Department of Health. There are only a few installations which are utilizing burial as a mode of disposal at present. Texas' waste disposals will be controlled under newer requirements as they become necessary. It is realized that Federal controls would not be instituted, which would pre-empt the State's activities.

GENERAL STATEMENT

The impact of atomic energy in Texas has not been limited to fields of direct application such as power development, scientific research, and medical diagnosis or therapy. The glow of this new industry is reflected through almost every phase of our modern society. Many organizations have had to re-evaluate their operations to bring this new factor into scope. Such is the case in the field of public health.

Public Health need no longer be concerned mostly with communicable diseases spread through insanitary conditions or by carriers. As a result, among several new subjects during the last fourteen years we have become increasingly aware that exposure to ionizing radiation could produce injury to the public. This is not to say that such biological injury was unknown prior to 1945. Many years of experience had been logged in the use of x-rays but for the most part these exposures were under the direction of physicians and only a small segment of the population was involved. The coming of nuclear reactors made radioactive isotopes widely available and at a cost which was relatively low. With the employment of these isotopes throughout our Texas economy the biological effect of the materials has changed from one of individual interest to one of wide public health concern.

LEGISLATION

The Texas State Board of Health and its operating agency, the State Department of Health, is charged by law with the responsibility of protecting the health of the citizens of Texas. To meet its obligations to the citizens, the Board of Health found it necessary to expand their activities to include this new health hazard. The Commissioner of Health, Doctor Henry A. Holle, was a charter member of a Texas Advisory Committee on Atomic Energy which held its first meeting in November 1955.* At a subsequent Committee meeting held early in 1956, the obligation of the State in regard to regulations involving health and safety was explored. Recognizing the necessity of adequate State control in this area, the Committee endorsed the establishment of regulations at an early date.

After a survey of regulations existing in other states and a study of the recommendations of the National Committee on Radiation Protection, regulations were drafted and submitted to the State Board of Health for their initial consideration in March 1956. In June, 1956 the Board adopted the "Regulations on Radiation Exposure" which became effective on 1 September 1956 (Inclosure 1). These have been well known to the AEC with whose representatives we have worked closely in a continuing and mutually beneficial manner.

The regulations apply to the manufacture, use, storage, handling, transportation or disposal of radioactive materials and radiation-producing machines. This includes naturally occurring radioactive materials and those artificially produced, as well as all x-ray equipment, particle accelerators, and nuclear reactors. The regulations are not applicable to the diagnostic or therapeutic levels of exposure to radiation by those who are licensed in Texas to practice the healing arts. Certain other exemptions from the regulations are materials or other conditions which preclude a health hazard.

*This Committee, appointed by a former Governor, was not re-established as of January, 1957, hence has no official existence.

The legal basis for the adoption of such regulations is granted through Articles 4419 and 4418d of the Revised Civil Statutes, State of Texas. The pertinent sections of these two Articles read respectively as follows:

> "The State Board of Health shall have ganeral supervision and control of all matters pertaining to the health of citizens of this State, as provided herein." (Art. 4419)

> **"He shall have the power, with the approval of the State Board of Health, to prescribe and promulgate such administrative rules and regulations, not inconsistent with any law of the State, as may be deemed necessary for the effective performance of the duties imposed by this or any other law upon the State Department of Health and its several officers and divisions." (Art. 4418d)

The Board of Health is also authorized to disseminate the Regulations as an industrial standard as per Article 4477, Section 19(b) of the aforementioned Statutes which reads as follows:

> "The Texas State Department of Health shall make available to the citizens of Texas current information concerning maximum allowable concentrations of toxic gases and such environmental standards as may pertain to the health and safety of the employees of industrial establishments in this State."

Two Articles of the Texas Penal Code may be applicable in controlling sources of ionizing radiation and radioactive waste but the ultimate results cannot be clearly visualized.

> Article 695 (423) Acts Injurious to Health states:

> "Whoever shall carry on any trade, business or occupation injurious to the health of those who reside in the vicinity, or suffer any substance which has that effect to remain on premises in his possession, shall be fined not less than ten nor more than one hundred dollars. Each day is a separate offense."

> Article 698b. Pollution of Public Bodies of Surface Water Prohibited has possible application where radioactive wastes are discharged into surface waters. The pertinent sections of this Article read as follows:

> "Section 1. It shall be unlawful for any person, firm, corporation, association, town, city or other political subdivision of this State, or any agent, officer, employee or representative of any person, firm, corporation, association, town, city or other political subdivision of this State to pollute any public body of surface water of this State."

**Refers to the Commissioner of Health.

> "Section 2. 'Pollute' is hereby defined to be the throwing, discharging or otherwise permitting to reach or to be introduced into any public body of surface water of this State any substance, material or thing in such quantity that the said water is thereby rendered unfit for one or more of the beneficial uses for which such water was fit or suitable prior to the introduction of such substance, material or thing, or is thereby rendered harmful to public health, game birds or game animals, fish or other edible aquatic animals, or endangers any wharf, or endangers or hinders the operation of any boat, or renders insanitary or unclean any bathing beach."

To minimize other problems as well as to solve a question as to the applicability of these two Articles to radioactive materials, the Texas State Department of Health has sponsored a bill recently introduced in the current session of the Legislature (S.B. 75) to provide definite requirements for registration of sources of ionizing radiation, with a specific penalty clause for non-compliance. Legislative action covering air pollution will also be sponsored. Discharge of radioactive contaminants into the atmosphere is regulated under the current regulations and would continue also under legislation, if passed.

REGISTRATION

One of the most significant aspects of the regulations adopted by the Board of Health is the requirement of registration of sources of ionizing radiation. Registration, which does not mean approval, is required of all to whom the regulations are applicable. Within thirty (30) days of commencement of use of radiation equipment or radioactive material, the State Department of Health must be notified as to location, nature, scope of operation and use. This is accomplished on a standardized form which has been prepared by the Division of Occupational Health, which administers the regulations.

Through this registration program and excellent relationships with the U. S. Atomic Energy Commission and their Licensing Division, the Texas State Department of Health has been able to maintain surveillance over the use of most radioactive materials in the State. As of January 1, 1959, there were some 325 individuals or organizations registered to utilize "by-product materials" and 280 to use radium. By-product materials are those produced directly or indirectly through the use of uranium. The U. S. Atomic Energy Commission has control over and licensed all of these isotopes. Radium is a naturally occurring radioactive material and, as such, is not under the control of the Atomic Energy Commission. Inclosure 2 indicates the geographical distribution of these registrants by county. Of the 91 counties in which isotopes and/or radium are employed, 60 employ both isotopes and radium, 20 employ radium only, and 11 use isotopes only.

WASTE DISPOSAL

Radium is normally employed in the form of sealed sources and as such presents no disposal problem except for the occasional fractured or leaking needle or plaque. Isotopes on the other hand are commonly used directly in their elemental forms or in tagged compounds. In these forms radioactivity is more apt to escape into the environment, either intentionally or unintentionally, during its utilization or as a waste product. There are no uranium processing plants in Texas and of the three reactors located within the State at only one site does the design permit release of waste products to the environment. Therefore isotopes are the only significant source of radioactive waste at the present time. The majority of the unsealed radioisotopes find their way into our sewers. In Table I are presented data from fourteen cities concerning the seven most used isotopes to show that even if we should make some very pessimistic assumptions--such as: (1) all of the unsealed activity goes into the sewer; (2) this material is discharged into the sewer in twelve equal increments each year; and (3) there is no decay of the material from its acquisition until it is discharged into the sewer--the current maximum permissible levels of activity are not exceeded. This is applying the same standard for sewage that is recommended for drinking water. It should not be inferred from these data that this condition will always be true. With the rapid increase in the application of radioisotopes and the almost certain construction of large power and research reactors in Texas, it is only a matter of time until we must face a waste disposal problem.

TABLE I

USE OF RADIOACTIVE ISOTOPES IN TEXAS

CITY	Average Sewage Flow(1) (MGD)	Estimated Annual Use of Isotopes (millicuries)(2)						
		I^{131}	P^{32}	Au^{198}	Co^{60}	S^{35}	Cr^{51}	C^{14}
		$3X10^{-5}$*	$2X10^{-4}$*	$3X10^{-3}$*	$2X10^{-2}$*	$5X10^{-3}$*	0.5*	$3X10^{-3}$*
Amarillo	7.8	150	100	1,000	-	-	-	-
		$4.2X10^{-7}$(3)	$2.8X10^{-7}$	$2.8X10^{-6}$	-	-	-	-
Austin	12	120	110	150	1	1	0.05	14
		$2.2X10^{-7}$	$2.0X10^{-7}$	$2.8X10^{-7}$	$1.8X10^{-9}$	$1.8X10^{-9}$	$9.2X10^{-11}$	$2.6X10^{-8}$
Baytown	2.5	60	-	-	0.01	-	-	12
		$5.3X10^{-10}$	-	-	$8.8X10^{-14}$	-	-	$1.1X10^{-10}$
Bellaire	1.5	1,000	-	-	200	3	-	0.6
		$1.5X10^{-8}$	-	-	$2.9X10^{-9}$	$4.4X10^{-11}$	-	$8.8X10^{-12}$
Corpus Christi	15	195	50	500	2	-	-	-
		$2.0X10^{-10}$	$7.3X10^{-11}$	$7.3X10^{-10}$	$2.9X10^{-12}$	-	-	-
Dallas	78	9,000	7,100	8,400	-	-	-	-
		$2.5X10^{-6}$	$2.0X10^{-6}$	$2.4X10^{-6}$	-	-	-	$1.4X10^{-8}$
El Paso	14	700	530	1,000	1	-	10	-
		$1.2X10^{-6}$	$8.3X10^{-7}$	$1.6X10^{-6}$	$1.6X10^{-9}$	-	$1.6X10^{-8}$	-
Ft. Worth	35	4,100	1,100	2,500	-	-	-	-
		$2.6X10^{-9}$	$6.9X10^{-10}$	$1.6X10^{-9}$	-	-	-	-
Galveston	6.0	100	10	-	0.024	42	17	11
		$3.7X10^{-10}$	$3.7X10^{-11}$	-	$8.8X10^{-14}$	$1.5X10^{010}$	$6.2X10^{-11}$	$4.0X10^{-11}$
Houston	85	25,000	1,500	3,200	450	24	500	37
		$6.5X10^{-9}$	$3.9X10^{-10}$	$8.3X10^{-10}$	$1.2X10^{-10}$	$6.2X10^{-12}$	$1.3X10^{-10}$	$9.6X10^{-12}$
McAllen	2.4	200	75	1,000	0.01	-	-	-
		$1.8X10^{-9}$	$6.9X10^{-10}$	$9.2X10^{-9}$	$9.2X10^{-14}$	-	-	-
Midland	4.3	1,120	-	-	-	-	-	-
		$5.7X10^{-9}$	-	-	-	-	-	-
San Antonio	68	2,200	250	500	-	-	-	-
		$7.1X10^{-10}$	$8.1X10^{-11}$	$1.6X10^{-10}$	-	-	-	-
Temple	3.8	1,500	-	1,500	1	-	4	-
		$8.7X10^{-9}$	-	$8.7X10^{-9}$	$5.8X10^{-12}$	-	$7.3X10^{-11}$	-

* Maximum Permissible Concentration of each Isotope in Water Expressed in mc/ml

(1) Where information was not available concerning the average daily sewage flow the values given were obtained by assuming a population contribution of 80gpd. per capita.

(2) Values were obtained from State Registration forms.

(3) Second value in each item is isotope concentration in sewage.

OCCUPATIONAL HEALTH REGULATIONS

RADIATION EXPOSURE

(Supplements Regulations on Radiation Exposure,
OH–1, September 1, 1956 by Addition to Section 7(a))

Effective September 15, 1957

CONSULT LOCAL HEALTH DEPARTMENTS AND PHYSICIANS

FOR

INFORMATION AND ADVICE

ON METHODS OF CONTROL OVER

HEALTH HAZARDS TO ALL WORKERS

AND

INDUSTRIAL DISEASES AND INJURIES

TEXAS STATE DEPARTMENT OF HEALTH
DIVISION OF OCCUPATIONAL HEALTH
Austin 1, Texas

2821

This supplementary amendment was adopted by the Texas State Board of Health on September 9, 1957, in accordance with the authority granted in Article 4418d of the Revised Civil Statutes, State of Texas, and is promulgated in accordance with Article 4477, Section 19.

Add to the end of Section 7(a), page 4, OH-1, September 1, 1956, Regulations on Radiation Exposure, (approved by the Texas State Board of Health June 18, 1956):

"No individual except one authorized by and licensed in accordance with Texas' Statutes to engage in the healing arts, or one properly trained and serving under responsible direction of such a licensed individual, shall utilize radiation, including fluoroscopy, in any type of examination of a person, nor expose intentionally any part of a person to an excessive radiation dose. (See 4(b) for authorized exemptions.) In applying this regulation shoe-fitting fluoroscopes are hereby declared as being neither for diagnostic nor therapeutic purpose."

REGULATIONS

ON

RADIATION EXPOSURE

Effective Sept. 1, 1956

ADOPTED BY

THE TEXAS STATE BOARD OF HEALTH

TEXAS STATE DEPARTMENT OF HEALTH

AUSTIN, TEXAS

OH-1

37457 O—59—vol. 4——21

PREFACE

a. The main endeavor of these regulations is to incorporate the basic technical principles that should be applied uniformly.

b. These regulations are based on present knowledge of radiation and its biologic effects; with further research this information can be expected to improve. The Texas State Department of Health will publish from time to time such new information as it deems pertinent, giving references to the sources of new data.

c. Although the values proposed for maximum permissible dose are such as to involve a risk that is small compared to the other hazards of life; nevertheless in view of the unsatisfactory nature of much of the evidence on which the judgments must be based, coupled with the probability that certain radiation effects are irreversible and cumulative, it is strongly recommended that every effort be made to reduce the dose of all types of ionizing radiations to the lowest practicable level.

d. Because it is not possible to predict the period of time over which an individual may be occupationally exposed to radiation, it is assumed that he will be so exposed at more or less a uniform average rate over his entire adult lifetime. Occasional exposure rates higher than those specified cannot be justified by assuming lower future exposures because of the arbitrary limitation that would be placed on a person's future freedom of action. (See sections 7 and 15 of these regulations.)

e. The maximum permissible dose for an individual shall be considered to include all doses from all types and energies of radiation, whether delivered simultaneously or successively, during the period of measurement to the region of interest.

f. The requirements specified in these regulations are consistent with the recommendations of the National Committee on Radiation Protection.

g. These regulations were adopted by the Texas State Board of Health on June 18, 1956 in accordance with the authority granted in Article 4418d of the Revised Civil Statutes, State of Texas. Dissemination of this information as an industrial standard is also in accordance with Article 4477, Section 19(b).

1. SCOPE

It is the purpose of these regulations to state such requirements as shall be applied in the use of all radiation, radiation machines, and radioactive materials to insure the maximum safety to all persons at, or in the vicinity of, the place of use, storage, or disposal thereof. These regulations are intended to be consistent with the best of use of radiation machines and radioactive materials.

2. APPLICATION

(a) All radiation machines and radioactive materials shall be manufactured, used, stored, handled, transported, or disposed of in such manner that no person shall receive an excessive radiation dose therefrom. Except as exempted by the provisions of section 4 of these regulations, the manufacture, use, storage, handling, transportation, or disposal of radiation machines and radioactive materials shall be subject to the specific regulations provided below.

(b) For the purposes of these regulations, radiation machines and radioactive materials used by, or in the possession of, an employee within the scope of his duties shall be considered to be in the possession of the employer.

3. DEFINITIONS

For the purposes of these regulations the following definitions shall apply:

Absorbed dose of any radiation is the amount of energy imparted to matter by ionizing particles per unit mass of irradiated material at the place of interest.

Adult is a person of age 18 or more. This age limitation is for radiation-protection purposes only and bears no relationship to age limits for social, political, or other legal considerations.

Agency is that governmental agency that is given the responsibility for administering these regulations. In this case, the Texas State Department of Health.

Body burden is the amount of radioactive material in the body at the time of interest.

Critical organ is that part of the body that is most susceptible to radiation damage under the specific conditions considered.

Excessive radiation dose is a dose of radiation in excess of the maximum permissible dose. (Depending upon the degree of excess, these conditions represent serious hazard only when they are maintained or repeated frequently over long periods of time.)

Harmful effectis any body injury, disease, or impairment, except where such condition is transitory, infrequent, or of short duration, and does not endanger persons so affected.

Installation is the area of radiation hazard under the administrative control of the person or organization possessing the source of radiation.

Maximum permissible dose is a dose of radiation that, in the light of present knowledge, is not expected to cause appreciable bodily injury to a person at any time during his lifetime.

Personnel monitoring is the determination of the radiation dose received by a person during a specified period.

Population group is a civil population (usually more than 100,000 persons) living in geographic proximity and generally dependent upon the same sources of food and water.

Qualified expert is a person fitted by training and experience to perform dependable radiation surveys, to oversee radiation monitoring, and to estimate the degree of radiation hazard. If the ability of a qualified expert is questioned, the Agency shall be the judge of his qualifications, in regard to which it may consider the testimony of other persons whom it deems expert.

Rad is the unit of absorbed dose and is equal to 100 ergs per gram. It is a measure of the energy imparted to matter by ionizing particles per unit mass of irradiated material at the place of interest.

Radiation is gamma rays and x-rays, alpha and beta particles, high-speed electrons, neutrons, protons, and other nuclear particles; but not sound or radio waves, or visible, infrared, or ultraviolet light.

Radiation hazard is any condition that might result in the exposure of persons to radiation in excess of the maximum permissible dose.

Radiation machine is any device that produces radiation when the associated control devices are operated.

Radioactive material is any material, solid, liquid, or gas, that emits radiation spontaneously.

Relative Biological Effectiveness (RBE) is the biological effectiveness of one type and energy of radiation, relative to that of lightly filtered x-rays generated at potentials of 200 to 300 kilovolts, for the particular biological system and biological effect, and for the conditions under which the radiation is received.

Rem is the quantity of any radiation such that the energy imparted to a biological system (cell, tissue, organ, or organism) per gram of living matter by the ionizing particles present in the region of interest, has the same biological effectiveness as an absorbed dose of 1 rad from lightly filtered x-rays generated at potentials of 200 to 300 kilovolts. A dose in rems is equal to the dose in rads multiplied by the appropriate RBE.

Sealed source is a quantity of radioactive material so enclosed as to prevent the escape of any radioactive material, but at the same time permitting radiation to come out for use.

Survey is the evaluation of radiation near a source by, or under the supervision of, a qualified expert.

Other scientific and technical terms not herein specifically defined shall be used in accordance with the definitions in (1) recommendations of the National Committee on Radiation Protection as published in Handbooks of the National Bureau of Standards, or (2) National Research Council Glossary of Terms in Nuclear Science and Technology, with preference being in the order given above.

4. EXEMPTIONS

(a) These regulations shall not apply to the following materials, machines, or conditions:

(1) Natural radioactive materials of an equivalent specific radioactivity not exceeding that of natural potassium.
(2) Radioactive material in such quantity that if the entire amount were taken internally, continuously, or at one time by a person, no harmful effect would be likely to result. Listings of the upper limits of quantities of radioactive materials that shall be exempt from these regulations and from registration are given in section 15.c and table 1 of these regulations. These limits apply only for radioactive material not contained in sealed sources.
(3) Radioactive materials in sealed sources in total quantities not exceeding 1 millicurie for a given installation.
(4) Timepieces, instruments, novelties, or devices containing self-luminous elements, except during manufacture or repair of the self-luminous elements themselves.
(5) Electrical equipment that is primarily not intended to produce radiation and that, by nature of design, does not produce radiation at the point of nearest approach at a weekly rate higher than one-tenth (1/10) the appropriate permissible dose for any critical organ exposed. The production testing or production servicing of such equipment shall not be exempt.
(6) Radiation machines not being used in such manner as to produce radiation.
(7) Any radioactive material being transported on vessels, aircraft, railroad cars, or motor vehicles in conformity with the regulations adopted by any agency having jurisdiction over safety during transportation.

(8) The Agency may exempt radiation machines or radioactive materials known to be without hazard, and shall authorize the labeling of the ones that it does exempt.

(b) Nothing in these regulations shall be construed to limit the kind and amount of radiation that may be intentionally applied to a person for diagnostic or therapeutic purposes by, or under the direction of, a physician or dentist.

5. STANDARDS

Recommendations of the National Committee on Radiation Protection as published in Handbooks of the National Bureau of Standards shall be used as guides or standards or as a basis for calculations to obtain or maintain safe working conditions within the meaning of the regulations herein, but shall not be considered in whole or in part as a portion of these regulations unless specifically so stated.

6. REGISTRATION

(a) Any person using or operating any radiation machine, or storing, manufacturing, using, or handling any radioactive material, shall notify the Agency of the fact in writing within 30 days following the commencement thereof. Said notice shall state the location, nature, and scope of such operation, use, or storage, and shall be reviewed and if necessary brought up to date annually thereafter.

(b) The notification in paragraph (a) above shall include an estimate of any further accession of radiation machines or radioactive material expected during the ensuing year. Any accession in excess of the estimate shall be registered promptly.

(c) Acknowledgement of registration shall not imply the approval by the Agency of the manufacture, storage, use, or operation described in the registration, but shall merely indicate that the Agency has a record of the locations and establishments where radiations are used.

7. MAXIMUM PERMISSIBLE DOSE

(a) The exposure of persons to radiation shall always be kept to the lowest practicable level.

(b) When the source of radiation is outside the body, the maximum permissible dose rate shall not exceed those values specified in section 15.d and table 2 of these regulations.

(c) Quantities of radioactive material on the surface of the body, or on clothing worn by the person, shall not exceed those that will result in average dose rates to any portion of the body greater than the applicable permissible value specified in section 15.d and table 2 of these regulations. (The skin will generally be the critical organ for

sufficiently small sources of radiation. For such cases, the area over which the dose is averaged shall be of the order of 1 square centimeter.) Wounds, cuts, or abrasions of the skin involving contamination shall be given immediate medical attention for the removal of such contamination.

(d) The maximum permissible dose for an individual shall be considered to include all doses, from internal and external sources, from all types and energies of radiation, whether delivered simultaneously or successively, to the region of interest, during the period of measurement.

(e) Radiation dose to the tissues of the body from radioactive materials within the body shall be controlled by limiting the average rates at which radioactive materials are taken into the body either by inhalation or by ingestion. Where such intake results from the occurrence of a radioisotope in the air or water, the average concentration of the radioisotope in the air or water used by the individual shall not exceed the maximum permissible concentration specified in table 5 of these regulations.

(f) The determination of the dose received by persons and degree of hazard present in all places to which these regulations apply shall be guided by nationally recognized standards such as (1) the recommendations of the National Committee on Radiation Protection as published in Handbooks of the National Bureau of Standards, and (2) Safety Standards of the American Standards Association.

(g) The radiation dose to any population group shall be limited to one-tenth (1/10) the maximum permissible amounts stated in section 15 of these regulations.

8. PERSONNEL MONITORING: AREA RADIATION SURVEYS

(a) All accessible areas in the vicinity of radiation-producing sources shall be surveyed by, or under the direction of, a qualified expert using suitable instruments and methods for measuring radiation, to determine the maximum levels of radiation to which persons may be exposed. For protection purposes these measurements shall be reduced to weekly doses taking into consideration the amount of time the radiation is being produced, the work week, and the fraction of the week that any person might be exposed to the radiation.

(b) In lieu of an actual survey a written statement made by a qualified expert based on his analysis of the situation shall be acceptable as evidence of the absence of radiation hazard in a given area.

(c) Personnel monitoring shall be required for each individual for whom there is any reasonable possibility of receiving a weekly dose of all radiations exceeding one-quarter (1/4) of the maximum permissible amounts specified in sections 7.b through 7.f of these regulations taking into consideration the use of protective gloves, aprons, or

other radiation-limiting devices; except that, continuation of personnel monitoring shall not be required if the average dose over a period of 8 weeks proves to be less than one-half (1/2) the maximum permissible amounts specified in section 7.b through 7.f of these regulations. If the specified operating conditions are changed, a new monitoring test over an 8-week period shall be made.

(d) Routine monitoring of persons occupationally exposed to radiation from radiation machines shall not be required when all of the following conditions are met:

(1) A qualified expert has specified the operating conditions under which there is no reasonable chance that any person will be exposed to more than one-quarter (1/4) the maximum permissible dose.
(2) The operating conditions in (1) above are made known to all persons who may be occupationally exposed to the radiation.
(3) The installation continues to operate only under the specified conditions.

(e) Regularly scheduled monitoring of the air within the installation for radiation or radioactive content shall be required when there is any reasonable possibility that the average levels of activity therein may exceed one-quarter (1/4) the amount specified in table 5 of these regulations. Measurements averaged over a maximum period of 13 weeks shall be permissible, but in any case there shall be sufficient monitoring to insure that no radiation hazard exists.

9. RADIATION-EXPOSURE RECORDS AND REPORTS

(a) Records of all measurements required under section 8 above shall be kept available for inspection by the Agency or its representative upon demand. Personnel-monitoring records shall include the Social Security numbers of the workers concerned as an aid in keeping track of an individual's total exposure.

(b) Records of the amount, kind, and disposition of radioactive materials purposefully removed from the installation shall be maintained and available for inspection by the Agency or its representative upon demand.

(c) Upon termination of employment of a person, the Agency shall, upon request, be supplied with a summary statement of that person's average radiation dose. (The estimated maximum dose shall be stated if no personnel monitoring has been carried out.) This record shall include statements of any circumstances wherein the dose to the employee, from any source of radiation, exceeded those specified in these regulations.

(d) When it is known or believed that an accidental dose to a person in the installation may have exceeded five times the amount permitted by applicable portions of sections 7.b through 7.f of these regulations, all facts relative to the occurrence shall be reported in detail to the

Agency within 7 days of the discovery thereof, and a copy of the report shall be put in that person's personnel file. The cause of the overexposure shall immediately be sought out and corrected.

10. RESPONSIBILITY

(a) All work performed in an installation where radiation may be present shall be under the direction of a person responsible for the radiation safety therein. His name shall be reported to the Agency.

(b) The person in charge of the radiation safety in an installation shall have the following responsibilities:

(1) He shall inform himself of the hazards attendant upon the presence of radiation in the installation and, if necessary to this end, obtain the services of a qualified expert.

(2) He shall provide, or cause to be provided, any necessary instruction concerning the attendant radiation hazards and safe working practices, to all employees whose duties necessitate the handling of radioactive material or the operation of any machines that produce radiation in amount that leads to hazard, and to all other employees who are not regularly employed at such work but who may occasionally be exposed to radiation.

(3) He shall insure beyond reasonable doubt that all persons working with radiation machines or radioactive materials, and all authorized visitors to areas where radiation may be present, are properly and adequately instructed in the use of all necessary safeguards and procedures, and are supplied with such auxiliary devices as may be necessary for safety.

(4) He shall insure beyond reasonable doubt that no radioactive material (including that in patients, animals, and equipment) is allowed to leave the jurisdiction of the radiation user under circumstances that may subject other persons to radiation in amounts in excess of those indicated in sections 7.b through 7.f of these regulations.

(5) He shall insure beyond reasonable doubt that any area, inside or outside the installation, normally occupied by adults not primarily engaged in radiation or associated work, cannot be subjected to radiation levels exceeding the maximum permissible amounts indicated in sections 7.b through 7.f of these regulations.

(6) He shall insure beyond reasonable doubt that any area, inside or outside the installations, that may be habitually occupied by persons under 45 years of age and not engaged in radiation work, cannot be subjected to radiation levels exceeding one-tenth (1/10) the maximum permissible amounts indicated in sections 7.b through 7.f of these regulations, except that such exposure may be averaged over 1 year. Normal occupational exposures of pregnant women should be considered as acceptable risks.

(7) He shall notify the building superintendent or other appropriate official of the existence of any areas not normally occupied but in which hazardous radiation exposure may take place; e.g., an air-conditioning equipment room beneath x-ray installation.

(8) He shall notify the building superintendent or other appropriate official of the existence of any conditions or situations that, while not normally considered a radiation hazard, may become a hazard under special or unusual circumstances; e.g., entrapment of waste in a drainage line.

(9) He shall, by means of appropriate surveying or monitoring procedures, insure that radioactivity discharged to the atmosphere, at any point where persons may breathe the air, shall be maintained at an average concentration of radioactivity below the maximum permissible levels indicated in section 7 of these regulations.

(c) Every employee and authorized visitor shall be responsible for using such safety devices as are furnished for his protection and for carrying out all radiation-safety rules that concern or affect his conduct.

11. STORAGE OF RADIOACTIVE MATERIALS

(a) Radioactive materials shall be stored or kept in such a manner as to insure that the dose rate therefrom shall not exceed the appropriate limits specified in section 7 of these regulations.

(b) Vaults or rooms in which radioactive materials are stored shall be so located and/or constructed that no person shall be exposed to radiation therefrom in excess of the appropriate limits set forth in sections 7.b through 7.f of these regulations.

(c) Radioactive materials in a workroom or other location where persons are regularly or frequently present shall be enclosed in containers of such thickness, material, and construction, or otherwise shielded in such manner, that no person will be exposed to radiation in amounts greater than those indicated in sections 7.b through 7.f of these regulations.

(d) Vaults or rooms used for storing materials that may emit radioactive gases shall be suitably ventilated in such a manner that the gases do not constitute a radiation hazard.

(e) When there is any possibility that chemical, radiation, or other action might weaken or rupture the container of radioactive material sufficiently to cause leakage therefrom, the container shall be provided with a suitable secondary tray or catchment adequate to retain the entire amount of radioactive material.

(f) Each container of radioactive material in storage shall, in addition to the standard radiation-hazard symbol (see section 13.c of these regulations), be labeled in such manner that the kind and quantity of material, the date of measurement, and the name of the person responsible for the material can be easily and quickly determined.

(g) Storage containers for radioactive material in excess of 1 curie shall be designed to be resistant to fire and earthquake damage, and to

maintain reasonable temperatures. Containers shall be structurally sound over the period of intended use with due regard to corrosion, radiation, and temperature effects that may develop.

(h) Suitable provision shall be made to minimize the hazard to emergency workers in the event of fire and in situations where earthquake, flood, and windstorm potentials exist.

12. RADIOACTIVE-CONTAMINATION CONTROL

(a) All work with radioactive materials shall be carried out under such conditions as to minimize the possibility of any contamination that would result in any person's being subjected to radiation levels exceeding those specified in section 7 of these regulations.

(b) Where the nature of the work is such that a person or his clothing may become contaminated to such degree as to present a hazard, both shall be suitably monitored. Any contamination leading to doses in excess of the values specified in section 7 of these regulations shall be removed from the contaminated person before that person is permitted to leave the work area. Clothing or other material having contamination in excess of the amounts indicated in section 7 of these regulations shall not be taken from the work area or released to public laundries or cleaners.

(c) Under conditions in which the Agency considers it advisable it may devise or approve a suitable pattern of work rules applicable to individual users. These may vary from one user to another.

(d) Every person using radioactive materials not enclosed in a sealed source shall have on hand or immediately available an instrument or instruments suitable for detecting and measuring contamination in accordance with the requirements of this section. These instruments shall be maintained in proper calibration. Under special circumstances, the Agency may require the same or similar instrumentation for users of radioactive materials in sealed sources.

(e) Any accidental release of radioactive material beyond the control or jurisdiction of the installation shall be reported to the Agency immediately.

13. RADIATION INFORMATION LABELING

(a) All radiation machines shall be clearly labeled as follows:

CAUTION - X-RAYS

This equipment produces x-rays when energized.

(Labels as required under the Federal Food, Drug and Cosmetic Act may be substituted for the above label.)

(b) All radioactive material not in process or in possession of the user shall be clearly labeled as follows:

(1) Containers for sealed sources of external hazard only:

CAUTION - RADIATION

(Where a time limit is specified, it should be posted.)

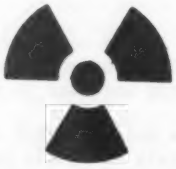
(2) Radioactive material in loose bulk or unsealed containers - internal hazards primarily:

DANGER - RADIOACTIVE MATERIAL

The material contained herein should not be allowed to enter the body either by inhalation, ingestion, or through wounds in the skin.

(Labels as required under the Atomic Energy Act may be substituted, where appropriate, for the above labels.)

(c) The standard symbol for designating any radiation hazard shall be:



The standard color specification shall be a background of yellow with lettering and distinctive symbol in purple (magenta). The use of this symbol for any other purpose is expressly prohibited. The symbol and lettering shall be as large as practical, consistent with size of the equipment or material.

(d) All radioactivity containers, storage areas, work areas, or other normally occupied areas where a radiation hazard may exist shall be posted with accepted radiation-hazard labels, except where such labels may be a source of disturbance to patients undergoing radiation treatment.

(e) Any areas where a radiation hazard may exist on a frequent or infrequent basis, but which are not readily accessible and are so situated as to be occupied only under infrequent and special circumstances, shall be posted with accepted radiation-hazard labels.

(f) All areas that are readily accessible but not normally occupied, and where a radiation hazard may exist on a frequent or infrequent basis, shall be suitably fenced off and posted with the accepted radiation-hazard label.

(g) All radiation-hazard labels posted when a radiation hazard existed shall be removed when the hazard is no longer present.

14. DISPOSAL OF RADIOACTIVE WASTES

(Note: It is impractical or impossible at the present time to formulate detailed waste-disposal regulations that will provide adequate safety under all conditions without being unnecessarily restrictive under most conditions. Not only do the relevant factors vary with each locality, but virtually every radioisotope presents a different problem. A few broad rules applicable to cases of most common interest can be stated, but in general the procedures must be adjusted, in the light of the general guides specified in section 7 of these regulations, to take into account the particular circumstances involved.

(The disposal of radioactive waste, by the nature of the problem, develops situations different from those encountered in the normal handling of radioactive material under controlled conditions. Once a disposal event has taken place all further control over the material usually is completely out of the hands of the disposer; an irreversible train of events will have begun. It is therefore essential that special care and consideration be exercised before any disposal operation is commenced.)

(a) Users of radioactive materials shall release these materials only in such manner that the radioactive material discharged, in combination with that discharged by other users, will not cause contamination of the environment that may result in a person or persons receiving an excessive radiation dose. If several users are discharging radioactive wastes to the same environment, they shall, upon being notified of the fact, cooperate in limiting the release and shall file with the Agency a statement of their agreed pro-rata releases. If this is not done within a reasonable time the Agency arbitrarily may assign quotas to them severally.

(b) Users who release radioactive material may take reasonable advantage of the environmental factors (dilution, dispersion, etc.) to minimize the cost of disposal, provided they meet the performance requirements indicated in paragraph (a) above. Nothing in these regulations shall be construed as permitting release of materials that would be unlawful for other reasons.

(c) Prior to and during design and construction of facilities for the handling and disposal of radioactive wastes, users of radioactive materials may obtain opinions from the Agency regarding the probability of meeting these regulations. However, the user shall remain responsible for meeting the performance standards related to radioactivity established by the Agency and shall allow representatives of the Agency to inspect and evaluate his methods of treatment and release.

(d) For purposes of protection of <u>population groups</u>, the limits of radioactivity resulting from disposal of radioactive material shall be determined on the following basis:

(1) The average concentration of that isotope in air at points where it is commonly used by humans or in water at points of supply (exclusive of treatment, if any) prior to use by humans shall not exceed ten percent (10%) of the maximum permissible levels recommended in table 5, section 15 of these regulations. Concentrations lasting only over a period of a few days may be allowed to exceed the values given in table 5, provided the average concentration over any interval of one year does not exceed ten percent (10%) of these values.

(2) Average rates of radiation dose to persons from radioisotopes outside their bodies shall not exceed ten percent (10%) of the values specified in Rules I through IV, section 15.d of these regulations.

(3) Average concentrations in portions of public waterways not used as sources for human consumption shall be consistent with health, economic, and recreational uses of the water and the future plans for its use that are under consideration by responsible authorities.

(4) For any radioisotope where the effective half-life in the body is less than 60 days, the term "average" as used above shall mean the arithmetic mean of a series of determinations representative of plant operations and environmental conditions over any period of 13 consecutive weeks; for other radioisotopes this arithmetic mean shall be taken over a period of any 12 consecutive months.

(5) If the permissible average concentration of a mixture of radioisotopes in air or water depends almost entirely on the concentration of one of the radioisotopes involved, for routine practical estimates the contributions of the other radioisotopes in the mixture may be neglected. Where more than one isotope is important, the permissible concentration shall be arrived at by adding the exposures to be received from each significant component.

(e) Radioactive wastes may be disposed of by dumping or burial only in areas approved by the Agency for that purpose. Areas approved for this purpose shall be designed and operated so that they comply with the other provisions of these regulations.

15. TECHNICAL STANDARDS, GUIDES, AND GENERAL INFORMATION TO BE USED IN ACHIEVING THE REQUIREMENTS OF THESE REGULATIONS

(a) It will be considered that the data in this section are the best currently available to serve as guides for the fulfillment of the spirit and intent of the regulations.

(b) Modifications in this section will be made whenever the Agency finds it necessary in order to conform to the best practice and new information made known through continuing research.

(c) Maximum amounts of radioactive material permitted without registration. Registration shall not be required for the possession or use of radioactive materials when the total quantities of one or more kinds of radioactive material in any one of the following groups, at any one time, is not exceeded:

Group 1, 1 microcurie
Group 2, 10 microcuries
Group 3, 100 microcuries
Group 4, 1,000 microcuries

Table 1 indicates the place of individual radioactive materials in this group. Any radioactive material not listed in table 1 shall be considered as being in Group 2.

TABLE 1. Ranges of limiting quantities detailed in table 5

Group 1: 1 microcurie
Pb 210, Ra 226, Ac 227, Pu 239, Am 241, Cm 242, Po 219, At 211, U 233

Group 2: 10 microcuries
Sc 46, Co 60, Sr 90, Ru 106, Ag 105, Te 129, I 131, Cs 137, Ce 144, Eu 154, W 181, Re 183, Ir 192

Group 3: 100 microcuries
P 32, Cl 36, Ca 45, Sc 47, Sc 48, V 48, Fe 59, Zn 65, Ga 72, As 76, Rb 86, Sr 89, Y 91, Nb 95, Tc 96, Rh 105, Ag 111, Cd 109, Sn 113, Te 127, Ba 140, La 140, Pr 143, Sm 151, Ho 166, Tm 170, Lu 177, Ta 182, Pt 191, Au 198, Au 199, Tl 200, Tl 204, Pb 203, Th 234, Pt 193

Group 4: 1,000 microcuries
H 3, Be 7, C 14, Na 24, S 35, K 42, Cr 51, Mn 56, Fe 55, Ni 59, Cu 64, Ge 71, Mo 99, Pd 103, Pm 147, Ir 190, Au 196, Tl 201, Tl 202, natural uranium, natural thorium

(d) Permissible dose from external sources of radiation. The following rules govern the occupational exposure of individuals to radiation from sources outside the body:

RULE I. IONIZING RADIATION OF ANY TYPE OR TYPES

For adults under 45 years of age whose entire body, or major portion thereof, is exposed to ionizing radiation from external sources for an indefinite period of years; the maximum permissible total weekly doses shall be 300 mrems in the bloodforming organs, the gonads, and the lenses of the eyes; 600 mrems in the skin; and the respective values of the weekly doses in millirems in all other organs and tissues of the body according to the basic permissible dose distribution. For persons 45 years of age or older similarly exposed, the corresponding maximum permissible total weekly doses shall be double the above-stated values, provided that the portion of the weekly dose in the lenses of the eyes contributed by radiation of high specific ionization does not exceed 300 mrems.

RULE II. X-RAYS (ROENTGEN RAYS, GAMMA RAYS) WITH PHOTON ENERGY LESS THAN 3 MEV

For adults under 45 years of age whose entire body, or major portion thereof, is exposed solely to x-rays with photon energies less than 3 Mev from external sources for an indefinite period of years; the maximum permissible total weekly dose shall be 300 mr measured in air at the point of highest weekly dose in the region occupied by the person, provided that the actual total weekly dose in the gonads does not exceed 300 mrads. For persons 45 years of age or older similarly exposed, the corresponding maximum permissible total weekly doses shall be double the above-stated values, provided that the actual total weekly dose in the lenses of the eyes does not exceed 600 mrads.

RULE III. RADIATION OF VERY LOW PENETRATING POWER (HALF-VALUE LAYER LESS THAN 1 MM OF SOFT TISSUE)

For adults of any age whose entire body, or major portion thereof, is exposed to ionizing radiation of very low penetrating power from external sources for an indefinite period of years; the maximum permissible total weekly dose in the skin shall be 1,500 mrems, provided that the total weekly dose in the lenses of the eyes does not exceed 300 mrems.

RULE IV-A. LOCAL EXPOSURE OF THE HANDS AND FOREARMS TO ANY IONIZING RADIATION

For adults of any age whose hands and forearms are exposed to ionizing radiation from external sources for an indefinite period of years; the maximum permissible total weekly dose shall be 1,500 mrems in the skin, provided the respective weekly doses in millirems in all other tissues of the hands and forearms are not in excess of those that would result from exposure to ordinary x-rays at a weekly dose of 1,500 mr in the skin.

RULE IV-AX. LOCAL EXPOSURE OF THE HANDS AND FOREARMS TO X-RAYS (ROENTGEN RAYS, GAMMA RAYS) OF ANY PHOTON ENERGY

For adults of any age whose hands and forearms are exposed solely to x-rays from external sources for an indefinite period of years, the maximum permissible total weekly dose shall be 1,500 mr in the skin.

RULE IV-B. LOCAL EXPOSURE OF THE FEET AND ANKLES TO ANY IONIZING RADIATION

For adults of any age whose feet and ankles are exposed to ionizing radiation from external sources for an indefinite period of years; the maximum permissible total weekly dose shall be 1,500 mrems in the skin, provided the respective weekly dose in millirems in all other tissues of the feet and ankles are not in excess of those that would result from exposure to ordinary x-rays at a weekly dose of 1,500 mr in the skin.

RULE IV-BX. LOCAL EXPOSURE OF THE FEET AND ANKLES TO X-RAYS (ROENTGEN RAYS, GAMMA RAYS) OF ANY PHOTON ENERGY

For adults of any age whose feet and ankles are exposed solely to x-rays from external sources for an indefinite period of years, the maximum permissible total weekly dose shall be 1,500 mr in the skin.

RULE IV-C. LOCAL EXPOSURE OF THE HEAD AND NECK TO ANY IONIZING RADIATION

For adults whose heads and necks are exposed to ionizing radiation from external sources for an indefinite period of years; the maximum permissible total weekly doses shall be 1,500 mrems in the skin and 300 mrems in the lenses of the eyes provided the respective weekly doses in millirems in all other tissues of the head and neck are not in excess of those that would result from exposure to ordinary x-rays at a weekly dose of 1,500 mr in the skin. For persons 45 years of age or older the weekly dose in the lenses of the eyes may be 600 mrems, provided that the portion contributed by radiation of high specific ionization does not exceed 300 mrems.

RULE IV-CX. LOCAL EXPOSURE OF THE HEAD AND NECK TO X-RAYS (ROENTGEN RAYS, GAMMA RAYS) OF ANY PHOTON ENERGY

For adults whose heads and necks are exposed solely to x-rays from external sources for an indefinite period of years; the maximum permissible total weekly doses shall be 1,500 mr in the skin and (a) 450 mr in the lenses of the eyes of persons under 45 years of age, (b) 600 mr in the lenses of the eyes of persons 45 years of age or older.

RULE V-A. ACCIDENTAL OR EMERGENCY EXPOSURE TO X-RAYS (ROENTGEN RAYS, GAMMA RAYS) WITH PHOTON ENERGY LESS THAN 3 MEV

Accidental or emergency exposure of the whole body of adults or parts thereof to x-rays with photon energy less than 3 Mev, from external sources, occurring only once in the lifetime of the person, under the conditions and in the respective doses stated below, shall be assumed to have no effect on the radiation tolerance status of that person.

(a) Exposure of the whole body - any adult. Total dose, measured in air: up to 25 r.

(b) Local exposure - any adult. Dose measured in air and additional to wholebody dose: (1) Hands and forearms, up to 100 r, (2) feet and ankles, up to 100 r.

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RULE V-B. PLANNED EMERGENCY EXPOSURE

Emergency work involving high-level exposure to x-rays with photon energies less than 3 Mev shall be carried out on the basis that the person will not receive doses higher than one-half the respective doses stipulated in Rule V-A. If the doses actually received in the performance of such work do not exceed the respective maximum doses stipulated in Rule V-A, the exposure may be considered to be in the category covered by Rule V-A. Women of reproductive age shall not be subjected to planned emergency exposure.

RULE V-C. ACCIDENTAL OR EMERGENCY EXPOSURE TO OTHER TYPES OF IONIZING RADIATION

Rules V-A and V-B are applicable to accidental or emergency exposure to ionizing radiation of any type and energy when the tissue doses resulting therefrom in the different organs and tissues of the body (expressed in rems) do not exceed numerically the respective tissue doses in rads resulting from exposure to x-rays with photon energy less than 3 Mev, under the conditions stipulated in Rule V-A; provided, however, that the portions of the respective tissue doses in rems contributed by radiation of high specific ionization do not exceed 50 percent of the total tissue doses.

RULE VI. EXPOSURE TO X-RAYS FOR MEDICAL REASONS

Exposure of any part of the body to x-rays resulting from ordinary medical diagnostic procedures shall be assumed to have no effect on the radiation tolerance status of the person concerned, provided that no contributory accidental or emergency exposure of the order of magnitude specified in Rules V has occurred within the previous 3 months.

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In exceptional cases in which it is necessary for a person to receive in 1 week more than the basic permissible weekly organ doses, the unit of time may be extended to 13 weeks (1/4 year); provided that the dose in any organ accumulated during a period of any 7 consecutive days does not exceed the respective basic permissible weekly dose by more than a factor of three; and provided further that the total dose in any organ accumulated during a period of any 13 consecutive weeks does not exceed 10 times the respective basic permissible weekly dose.

For an air dose of 300 mr/week, the critical tissue dose, including backscattering, will depend upon the energy of the x- or gamma rays and on the conditions of exposure. In general, it may be expected that the dose to the critical organ would not exceed the estimated values marked in table 2 with the superscript "b", thus $^{b}(\ )$. As the permissible dose to the gonads is specifically stated in Rule II, no superscript is applied to the gonad dose for persons under 45.

TABLE 2. Maximum permissible total weekly doses in critical organs under various conditions of external exposure

Conditions of exposure				Critical organ				
				Skin	Blood forming organs	Gonads	Lens of the eye	Air dose*
Part of body	Radiation	Unit	Adult age	Weekly doses in significant volume in region of highest dose area				
								mr
Whole body	Any radiation	mrem	Under 45	600	300	300	300	---
			Over 45	1,200	600	600	[a]600	---
Whole body	X-rays and gamma rays (up to 3 Mev)	mrad	Under 45	[b](450)	[b](400)	300	[b](450)	300
			Over 45	[b](900)	[b](800)	[b](800)	600	600
Whole body	Any radiation with HVL < 1 mm of soft tissue	mrem	Under 45	1,500	[c]300	[c]300	300	---
			Over 45	1,500	[c]600	[c]600	[c]600	---
Hands and forearms	Any radiation	mrem	Under 45	1,500	[d]300	300	300	---
			Over 45	1,500	[d]600	600	[a]600	---
Feet and ankles	Any radiation	mrem	Under 45	1,500	[d]300	300	300	---
			Over 45	1,500	[d]600	600	[a]600	---
Head and Neck	Any radiation	mrem	Under 45	1,500	[d]300	300	300	---
			Over 45	1,500	[d]600	600	[a]600	---

* Air dose means that the dose is measured by an appropriate instrument in air in the region of highest dose rate to be occupied by a person, without the presence of the human body or other absorbing and scattering material.

[a] Including not more than 300 mrems of radiation of high specific ionization.

[b] Rough estimates of maximum values resulting from specified air doses, under practical conditions of exposure.

[c] Limits for concurrent exposure to penetrating radiation.

[d] In main portion of body. Not in region of highest dose rate (hand, foot, or head).

In the case of exposure to radiation of very low penetrating power (HVL <1 mm of soft tissue) the values specifically stated in the Rules are 1,500 mrems for the skin and 300 mrems for the lens of the eye, and apply to adults of any age. Because with this radiation the bloodforming organs and gonads would receive a negligible dose, none is stipulated. In practice, however, the same individual may be exposed also to penetrating radiation. In this case the limits for these critical organs should be the same as usual. Because they are different for the two age groups, they are given separately. The lens dose for age 45 and over has been arrived at by analogous reasoning. These additional values are marked $^{c}[\ ]$ in table 2.

In the case of local exposure of the extremities or head and neck, no age distinction is made in the Rules. Again, because whole-body exposure may also occur, the appropriate figures for all critical organs are included. Bloodforming tissue (principally bone marrow) in the designated part of the body (hands, etc.) is in the "region of highest dose rate" and the doses in table 2 should be for a significant volume in this region. However, the high dose in this portion of the bloodforming organs is purposely disregarded in this case. The values marked with the superscript "d" apply to the main portion of the body.

(e) Maximum permissible neutron flux densities. Neutrons are most commonly measured in terms of their flux densities. Table 3 gives the maximum permissible flux densities for neutrons of various energies.

(f) Relative biological effectiveness. The relative biological effectiveness (RBE) applicable to exposure to radiation from external sources is given in table 4.

TABLE 3. Maximum permissible neutron flux densities

Neutron energy	Neutron flux n/cm²/sec.
0.025 ev	2,000
10 ev	2,000
10 kev	1,000
0.1 Mev	200
0.5 Mev	80
1 Mev	60
2 Mev	40
3 to 10 Mev	30

In these calculated values, it is assumed that the RBE for gamma rays is 1, and the RBE for protons is 10, in accordance with table 4. Based on 40 hr/week exposure.

TABLE 4. RBE values

Radiation	RBE	Biological effect
X-rays, gamma rays, electrons, and beta rays of all energies.	1.0	Whole-body irradiation (bloodforming organs critical).
Fast neutrons and protons up to 10 Mev.	10	Whole-body irradiation (cataract-formation critical).
Naturally occurring alpha particles.	Compare with 0.1 microcurie Ra, otherwise = 10.	Carcinogenesis.
Heavy recoil nuclei.	20	Cataract formation.

(g) Exposure to sources of radiation within the body. Table 5 gives the maximum permissible amounts of radioisotopes in the human body and maximum permissible concentrations in air and water.

(h) In the case of occupational exposure of 8 hr a day (assuming half the daily consumption of air and water in the 8-hr work period), 5 days a week, and 49 weeks a year, the values of maximum permissible concentrations of radioisotopes in air and water in the working area may be increased by a factor of 3 above those values listed in table 5, provided no nonoccupational exposure to radiation occurs.

(i) Recommendations of the National Committee on Radiation Protection. Recommendations on protection against the injurious effect of radiation, published as Handbooks by the National Bureau of Standards, are listed below:

H42 Safe Handling of Radioactive Isotopes
H48 Control and Removal of Radioactive Contamination in Laboratories
H49 Recommendations for Waste Disposal of Phosphorus-32 and Iodine-131 for Medical Users
H51 Radiological Monitoring Methods and Instruments
H52 Maximum Permissible Amounts of Radioisotopes in the Human Body and Maximum Permissible Concentrations in Air and Water
H53 Recommendations for the Disposal of Carbon-14 Wastes
H54 Protection Against Radiations from Radium, Cobalt-60 and Cesium-137
H55 Protection Against Betatron-Synchrotron Radiations up to 100 Million Electron Volts
H56 Safe Handling of Cadavers Containing Radioactive Isotopes
H58 Radioactive-Waste Disposal in the Ocean
H59 Permissible Dose from External Sources of Ionizing Radiation
H60 X-ray Protection (Revision of H41)
Burial of Radioactive Wastes in Soil (in preparation)

TABLE 5. Maximum permissible amounts of radioisotopes in total body and maximum permissible concentrations in air and water

Group	Radioisotope	Column I[a] Microcuries per milliliter of air	Column II[a] Microcuries per milliliter of water	Column III Microcuries in total body
--	A 41	5×10^{-7}	5×10^{-4}	30
2	Ag 105	1×10^{-5}	2	18
3	Ag 111	3×10^{-5}	4	36
1	Am 241	3×10^{-11}	1×10^{-4}	0.06
3	As 76	2×10^{-6}	0.2	10
1	At 211	3×10^{-10}	2×10^{-6}	6×10^{-4}
3	Au 198	1×10^{-7}	3×10^{-3}	10
3	Au 199	2.5×10^{-7}	7×10^{-3}	28
3	Ba 140 + La 140	6×10^{-8}	2×10^{-3}	5
4	Be 7	4×10^{-6}	1	670
4	C 14	5×10^{-7}	3×10^{-3}	250
3	Ca 45	3×10^{-8}	5×10^{-4}	65
3	Cd 109 + Ag 109m	7×10^{-8}	7×10^{-2}	40
2	Ce 144 + Pr 144	7×10^{-9}	4×10^{-2}	5
3	Cl 36	4×10^{-7}	2×10^{-3}	200
1	Cm 242	2×10^{-10}	9×10^{-4}	0.05
2	Co 60	1×10^{-6}	2×10^{-2}	3
4	Cr 51	8×10^{-6}	0.5	390
2	Cs 137 + Ba 137m	2×10^{-7}	1.5×10^{-3}	90
4	Cu 64	6×10^{-6}	8×10^{-2}	150
2	Eu 154	6×10^{-9}	3×10^{-2}	22
--	F 18	1×10^{-4}	0.9	24
4	Fe 55	6×10^{-7}	4×10^{-3}	1,000
3	Fe 59	1.5×10^{-8}	1×10^{-4}	11
3	Ga 72	3×10^{-6}	9	8
4	Ge 71	4×10^{-5}	9	67_4
4	H 3 (HTO or T_2O)	2×10^{-5}	0.2	10^4
3	Ho 166	3×10^{-6}	23	17
2	I 131	5×10^{-9}	3×10^{-5}	0.7
4	Ir 190	7×10^{-7}	1×10^{-2}	21
2	Ir 192	5×10^{-8}	9×10^{-4}	3.4
4	K 42	2×10^{-6}	1×10^{-2}	20
3	La 140	1×10^{-6}	1	24
3	Lu 177	5×10^{-6}	24	78
4	Mn 56	3×10^{-6}	0.15	2
4	Mo 99	2×10^{-3}	14	50
4	Na 24	2×10^{-6}	8×10^{-3}	15
3	Nb 95	4×10^{-7}	4×10^{-3}	90
4	Ni 59	2×10^{-5}	0.25	39
3	P 32	1×10^{-7}	2×10^{-4}	10

Group	Radioisotope	Column I[a] Microcuries per milliliter of air	Column II[a] Microcuries per milliliter of water	Column III Microcuries in total body
3	Pb 203	6.5×10^{-6}	0.1	57
4	Pd 103 + Rh 103	7×10^{-7}	1×10^{-2}	6
4	Pm 147	2×10^{-7}	1	120
1	Po 210 (sol.)	2×10^{-10}	3×10^{-5}	0.02
1	Po 210 (insol.)	7×10^{-11}	--	7×10^{-3}
3	Pr 143	7.5×10^{-7}	0.4	29
1	Pu 239 (sol.)	2×10^{-12}	1.5×10^{-6}	0.04
1	Pu 239 (insol.)	2×10^{-12}	--	0.008
1	Ra 226 + 1/2 dr[b]	8×10^{-12}	4×10^{-8}	0.1
3	Rb 86	4×10^{-7}	3×10^{-3}	60
2	Re 183	8×10^{-6}	8×10^{-2}	35
3	Rh 105	1×10^{-6}	1.5×10^{-2}	9
--	Rn 222 + dr[b]	[c] 1×10^{-7}	2×10^{-6}	--
2	Ru 106 + Rh 106	3×10^{-8}	0.1	4
4	S 35	1×10^{-6}	5×10^{-3}	300
2	Sc 46	7×10^{-8}	0.4	6
3	Sm 151	1×10^{-8}	0.2	420
3	Sn 113	6×10^{-7}	0.2	80
3	Sr 89	2×10^{-8}	7×10^{-5}	2
2	Sr 90 + Y 90	2×10^{-10}	8×10^{-7}	1
3	Tc 96	3×10^{-6}	3×10^{-2}	5
3	Te 127	1×10^{-7}	3×10^{-2}	4
2	Te 129	4×10^{-8}	1×10^{-2}	1.3
3	Th 234	6×10^{-7}	3	120
4	Th-natural(insol.)	3×10^{-11}	--	0.002
4	Th - natural	3×10^{-11}	4×10^{-7}	0.01
3	Tm 170	5×10^{-8}	0.25	19
1	U 233 (sol.)	1×10^{-10}	1.5×10^{-4}	0.04
1	U 233 (insol.)	1.6×10^{-11}	--	0.008
4	U - natural (sol.)	1.7×10^{-11}	7×10^{-5}	0.02
4	U - natural(insol.)	1.7×10^{-11}	--	0.009
3	V 48	1×10^{-6}	0.5	20
--	Xe 133	4×10^{-6}	4×10^{-3}	300
3	Xe 135	2×10^{-6}	1×10^{-3}	100
3	Y 91	4×10^{-8}	0.2	15

Group	Radioisotope	Column I [a] Microcuries per milliliter of air	Column II [a] Microcuries per milliliter of water	Column III Microcuries in total body
3	Zn 65	2×10^{-6}	6×10^{-2}	430
	All other beta or gamma emitters	1×10^{-9}	1×10^{-7}	---
	All other alpha emitters	5×10^{-12}	1×10^{-7}	---

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[a] The values given in Columns I and II apply to continuous exposures for 24 hr a day. Where exposure is incurred only during a work day of 8 hr, the values in Columns I and II may be multiplied by a factor of 3.

[b] dr stands for daughter products.

[c] The limit given in NBS Handbook 52 is 10^{-8} mc/m. The new value 10^{-7} mc/ml was adopted by the International Commission on Radiological Protection, 1953, and is now acceptable in the United States.

Distribution of Registrants
Ionizing Radiation Sources
in Texas
(Division of Occupational Health)

County	Total No. Registrations	X-Ray	X - R A Y Med*	X - R A Y Non-Med*	Isotopes Radium AEC License	Isotopes Radium	Reactor Isotopes (incl Radium) Med*	Reactor Isotopes (incl Radium) Non-Med*	Other Radiation Equipment
Anderson	5	5	4	1					
Andrews	5	2	1	1	1	3		4	
Angelina	9	7	4	3	2			2	1
Aransas	2	2	2						
Archer	1	1	1						
Atascosa	7	6	3	3		1		1	
Austin	8	8	7	1					
Bailey	5	5	4	1		1	1		
Bastrop	4	4	3	1					
Bee	2	2		2					
Bell	26	25	18	7	2	2	2	2	
Bexar	188	179	122	57	12	4	14	2	
Blanco	2	2	2						
Bosque	4	4	3	1					
Bowie	27	27	21	6	2	2	4		
Brazoria	22	21	13	8	2	2		4	1
Brazos	34	28	19	9	9	2		11	1
Brewster	1	1	1						
Brooks	3	2	1	1		1		1	
Brown	6	6	3	3	1	1	2		
Burleson	3	3	2	1					
Burnet	3	3	2	1					
Caldwell	10	7	6	1	2	3		5	

County	Total No. Registrations	X-Ray	X - R A Y Med.	X - R A Y Non-Med	Isotopes AEC License	Radium	Reactor Isotopes (incl. Radium) Med.	Reactor Isotopes (incl. Radium) Non-Med	Other Radiation Equipment
Calhoun	8	8	7	1	1	1		2	1
Callahan	3	3	2	1					
Cameron	40	39	29	10	4	4	7	1	
Camp	1	1		1					
Carson	1				1			1	
Cass	10	10	8	2					
Castro	2	2	2						
Chambers	1	1		1					
Cherokee	7	7	4	3	1	1	2		
Childress	11	10	8	2	1			1	
Clay	2	2	1	1					
Coleman	1	1		1					
Collin	17	16	12	4	1	1	1	1	1
Collingsworth	3	3	2	1					
Colorado	6	4	3	1	1	2		3	
Comal	9	9	8	1					
Comanche	3	3	3						
Concho	2	2	2						
Cooke	14	11	7	4	3	4	2	5	
Coryell	6	6	5	1					
Crane	5	4	4			1		1	
Crockett	2	2	2						
Crosby	4	4	2	2					
Dallam	2	2	1	1					
Dallas	521	470	403	67	38	30	42	26	4

County	Total No. Registrations	X-Ray	X - R A Y		Isotopes AEC License	Radium	Reactor Isotopes (incl. Radium)		Other Radiation Equipment
			Med.	Non-Med			Med.	Non-Med	
Dawson	8	8	5	3					
Deaf Smith	6	6	3	3	1	1	2		
Delta	1	1	1						
Denton	29	27	22	5	3	2	2	3	1
De Witt	6	6	4	2					
Dickens	1	1		1					
Dimmit	2	2	1	1					
Donley	1	1	1						
Duval	5	3	2	1	1	2		3	
Eastland	11	10	9	1	1	1		2	
Ector	18	9	4	5	8	5	1	12	
Edwards	1	1	1						
Ellis	12	12	9	3					
El Paso	100	96	83	13	6	3	6	3	1
Erath	10	10	8	2		1	1		
Falls	6	5	3	2	1	1	2		
Fannin	12	12	10	2					
Fayette	5	5	4	1					
Fisher	2	2	2						
Floyd	6	6	4	2					
Foard	1	1	1						
Fort Bend	20	19	15	4	1			1	
Franklin	1	1	1						
Freestone	1	1	1						
Frio	4	4	3	1					
Gaines	5	3	3		2			2	

County	Total No. Registrations	X-Ray	X - R A Y		Isotopes	Radium	Reactor		Other Radiation Equipment
			Med.	Non-Med	AEC License		Isotopes (incl. Radium) Med.	Non-Med	
Galveston	40	33	19	14	10	4	7	7	
Garza	2	2	1	1					
Gillespie	2	2	2						
Goliad	3	3	3						
Gonzales	7	7	7						
Gray	13	7	4	3	4	4		8	
Grayson	45	45	37	8	1	2	3		
Gregg	21	18	9	9	3	3	3	3	
Grimes	3	3	2	1					
Guadalupe	10	10	7	3					
Hale	13	13	8	5		1	1		
Hall	4	4	4						
Hamilton	2	2	2						
Hansford	4	4	4						
Hardeman	15	14	10	4	1			1	
Hardin	6	6	4	2	1			1	
Harris	550	496	382	114	74	39	44	69	6
Harrison	6	6	1	5	1			1	1
Haskell	6	5	4	1	1	1		2	
Hays	9	9	5	4					
Hemphill	2	2	2						
Henderson	5	4	3	1	1	1		2	
Hidalgo	71	65	53	12	5	7	5	7	
Hill	7	7	6	1		1	1		
Hockley	8	7	5	2		1		1	1
Hood	1	1	1						
Hopkins	6	5	3	2	1			1	

County	Total No. Registrations	X-Ray	X - R A Y Med.	X - R A Y Non-Med	Isotopes AEC License	Radium	Reactor Isotopes (incl. Radium) Med.	Reactor Isotopes (incl. Radium) Non-Med	Other Radiation Equipment
Houston	2	2	2						
Howard	8	7	4	3	1	2	1	2	
Hunt	16	16	14	2					
Hutchinson	10	7	4	3	2	2		4	
Jackson	12	12	9	3					
Jasper	4	4	4						
Jeff Davis	1	1	1						
Jefferson	100	88	66	22	12	15	11	16	2
Jim Hogg	1	1	1						
Jim Wells	12	8	6	2	2	3		5	
Johnson	16	16	13	3					
Jones	7	7	4	3		1	1		
Karnes	7	5	3	2	1	2		3	
Kaufman	16	16	14	2					
Kendall	3	3	3						
Kerr	11	10	7	3	1			1	
Kimble	1	1	1						
Kleberg	5	5	1	4					
Knox	1	1	1						
Lamar	9	9	5	4	2	3	4	1	
Lamb	10	10	7	3					
Lampasas	3	3	1	2					
LaSalle	3	3	2	1					
Lavaca	12	12	10	2					
Lee	2	2	1	1					
Leon	1	1	1						
Liberty	9	6	2	4	2	2		4	

County	Total No. Registrations	X-Ray	X - R A Y		Isotopes AEC License	Radium	Reactor Isotopes (incl. Radium)		Other Radiation Equipment
			Med.	Non-Med			Med.	Non-Med	
Limestone	3	3	2	1					
Lipscomb	1	1	1						
Live Oak	2	2	1	1					
Llano	3	3	3						
Lubbock	52	50	37	13	3	3	4	2	
Lynn	4	3	3						1
McCulloch	5	5	4	1					
McLennan	54	52	38	14	6		3	3	
Madison	2	2	2						
Marion	1	1		1					
Matagorda	17	15	10	5	2	1		3	
Maverick	2	2	2						
Medina	7	7	5	2					
Midland	15	11	9	2	3	3	2	4	
Milam	11	11	9	2		1	1		
Mills	1	1	1						
Mitchell	8	7	5	2		1		1	
Montague	4	3	2	1	1	1		2	
Montgomery	10	10	8	2					
Moore	8	8	6	2					
Morris	3	3	1	2					
Motley	1	1	1						
Navarro	11	11	9	2	1	3	4		
Newton	1	1	1						
Nolan	7	6	4	2	1	2	1	2	
Nueces	52	48	24	24	9	8	8	9	2

County	Total No. Registrations	X-Ray	X - R A Y		Isotopes	Radium	Reactor Isotopes (incl. Radium)		Other Radiation Equipment
			Med.	Non-Med	AEC License		Med.	Non-Med	
Ochiltree	6	5	4	1		1		1	
Orange	7	6	3	3	2	1		3	
Palo Pinto	14	14	13	1					
Panola	2	2	1	1					
Parker	10	10	8	2					
Pecos	3	3	3						
Polk	1	1		1					
Potter	40	38	29	9	1	2	1	2	1
Presidio	1	1		1					
Randall	1	1		1					
Reagan	1					1		1	
Red River	8	8	7	1					
Reeves	3	3	3						
Refugio	5	4	3	1	2	2	2	2	
Robertson	2	2	2						
Rockwall	2	2	2						
Runnels	6	6	4	2					
Rusk	2	2	1	1		1	1		
Sabine	1	1	1						
San Augustine	1	1		1					
San Patricio	12	12	9	3	1	1	2		
San Saba	3	3	2	1					
Scurry	15	8	5	3	4	6		10	
Shelby	2	2	1	1					
Smith	18	15	8	7	2	5	3	4	
Somervell	1	1	1						

County	Total No. Registrations	X-Ray	X - R A Y		Isotopes Radium				Reactor	Other Radiation Equipment
			Med.	Non-Med	AEC License		Isotopes (incl. Radium) Med.	Non-Med		
Starr	1	1	1							
Stephens	6	6	5	1						
Sterling	1	1	1							
Stonewall	1	1	1							
Swisher	3	3	2	1						
Tarrant	159	151	118	33	12	12	13	11	2	2
Taylor	28	25	16	9	5	6	5	6		
Terry	2	2	1	1						
Throckmorton	1	1	1							
Titus	4	4	3	1						
Tom Green	31	26	15	11	4	7	5	6		1
Travis	111	98	85	13	13	8	7	14		4
Trinity	2	2	2							
Tyler	2	2	1	1						
Upshur	3	3	2	1		1	1			
Upton	7	3	3		3	2		5		
Uvalde	5	5	3	2						
Val Verde	11	11	8	3						
Van Zandt	5	5	4	1						
Victoria	25	20	14	6	4	5	2	7		
Walker	2	2	2							
Ward	12	7	7		4	3		7		
Waller	1	1		1						
Washington	3	3	3							
Webb	13	13	11	2		1	1			
Wharton	15	14	10	4	1	2	2	1		

County	Total No. Registrations	X-Ray	X-RAY Med.	X-RAY Non-Med	Isotopes AEC License	Radium	Isotopes (incl. Radium) Med.	Isotopes (incl. Radium) Non-Med	Reactor	Other Radiation Equipment
Wheeler	9	9	7	2						
Wichita	26	19	9	10	6	8	4	10		
Wilbarger	4	4	3	1						
Willacy	4	4	3	1						
Williamson	12	12	9	3		1	1			
Wilson	3	3	2	1						
Winkler	9	8	7	1		1		1		
Wise	6	5	4	1		1		1		
Wood	4	4	2	2						
Yoakum	2	2	2							
Young	8	6	4	2	1	2		3		
Zavala	1	1	1			1	1			
218	3469	3163	2402	761	325	280	246	359	3	31

*Med. - (Medical) - includes: Doctor of Medicine, Doctor of Osteopathy, Doctor of Dental Surgery, Hospitals, Clinics
*Non-Med - (Non-Medical) - includes: all others

*Other Radiation Equipment - includes: Radioactive Static Eliminators, Beta Ray Gauges, Particle Accelerators, Electron Microscopes, etc.

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Experiences and Observations of the Washington State Department of Health on Problems Associated with the Disposal of Radioactive Wastes

by

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In cooperation with

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Washington State Department of Health

Session on Activities of Federal and State Agencies in Regulating Disposal of Radioactive Wastes, Feb. 3,1959

I have assumed in the preparation of this statement that the complex problems associated with the disposal of radioactive wastes have been thoroughly presented in previous testimony and that you are concerned in this session with the administrative and policy aspects and content of the related programs of the different branches and levels of government or regulatory agencies. With this in mind, I am hopeful that a summary of a few of our experiences and observations may be helpful.

I believe that a review of a joint activity with the AEC's Hanford Operations at Richland, Washington, will clearly illustrate many points relating to both the value and necessity of cooperation between the federal and state governments. At the AEC's Seminar on Disposal of Radioactive Wastes in January, 1949, the states were encouraged to establish working relationships with the Commission's installations. Based on this suggestion we approached Mr. Fred C. Schlemmer, then Manager of the Hanford Works. He was very responsive to our request that we participate in their waste disposal program, and apparently he had been giving the matter previous consideration as is indicated in his letter setting forth a proposal for our cooperation. I quote in part from

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[17] Born March 14, 1913, at Lynden, Wash. B.S. Degree in Civil Engineering, University of Washington, 1936. M.S. Degree in Sanitary Engineering, Harvard University, 1938. Associated with Washington State Department of Health for 17 years and am currently Chief Sanitary Engineer.

[18] Born July 20, 1918, at Baker, Oreg. B.S. Degree in Civil Engineering, Oregon State College 1940. Associated with Washington State Department of Health for 18 years, with exception of war service as an officer with U.S. Navy Seabees. Currenly in charge of the Department's Air Sanitation and Radiation Control Section.

a letter from Mr. Schlemmer to Dr. John A. Kahl, Director, Washington State Department of Health under date of June 8, 1949:

"During recent months, the Atomic Energy Commission has been approached, directly and indirectly, on a number of occasions with questions as to whether any of the activities performed at the Hanford plant result in radioactive contamination of the Columbia River which has primary or secondary effect upon the potability of the water or upon its suitability for agricultural and industrial uses; or whether there is any effect upon aquatic life in the River. As you know, the Atomic Energy Commission considers itself responsible to the people of the nation and to the people in the regions where the principal AEC plants are located, to conduct all atomic energy activities in such a fashion that there will be no endangering of any person as a result of those activities. We believe that we have been very successful in discharging that obligation.

"However, as the atomic energy industry develops and as the interest in the various ramifications of the atomic energy program including that of environmental sanitation becomes more widespread, there appears to develop a field in which both the AEC and certain other entities share in mutual interest. In this matter of radioactivity in the Columbia River there appears to be a field of interest which is common to both the AEC and also to other state and federal agencies concerned with the broad aspects of stream pollution, water potability, and public health. We accordingly consider it to be very desirable that a small group of the agencies concerned be able to meet at the Hanford Works to consider this problem.

"The general purposes of such a meeting will be to permit representatives of other interested agencies to:

"a. Become educated in the field of the health and sanitation aspects of radioactive material.

"b. Become familiar with the safeguards and techniques employed at the Hanford Works in controlling environmental contamination by radioactive substances.

"c. Assist the AEC in its long-range programs affecting public health.

"It appears to us that an appropriate group to start this work in the Northwest would comprise representatives from the following agencies:

"U. S. Public Health Service.
Washington State Stream Pollution Control Commission.
Oregon State Sanitary Authority.
Washington State Department of Health.

"We hereby cordially invite you to participate in this program, with the understanding that your representative will become a consultant to the Atomic Energy Commission * * *"

The group was formed with 4 engineers representing the agencies as suggested by Mr. Schlemmer, and has since been known as the Columbia River Advisory Group. After securing necessary clearances we held our first meeting in November, 1950. It consisted of a thorough inspection of the plant and its operation as they related to being a source of radioactive waste; and a briefing on the control program. In view of publicity given to the establishment and purpose of our group, and the evident concern of the public over possible effects of the operations on Columbia River, we felt compelled to issue a statement following our meeting. This statement read in part:

"The Columbia River Advisory Group to the Atomic Energy Commission conferred this week with AEC and General Electric Company officials at Richland to review and study methods used to dispose of liquid wastes reaulting from the operation of Hanford Works.

This group spent two and one-half days surveying waste disposal processes and conferring with Hanford officials.

"It is the consensus of the group, based upon information obtained, that so far as the Columbia River is concerned, there are no apparent water pollution hazards resulting from the operations at present.

"Waste disposal is a major problem. However, the operating agencies are using every means at their command to keep it under control. Future conferences are planned to review research and progress to insure that the Columbia River will continue to be protected."

We have had many, and a variety, of activities over the past 6 years. At our second meeting we were drawn in to evaluate a proposal by the U. S. Public Health Service to conduct a survey of the Columbia River in the vicinity of the Hanford Works. We supported this measure for two reasons: the states (Oregon and Washington) did not have the qualified personnel and other resources to carry out their normal responsibility of determining as to whether or not the waste control program of the Hanford Works was adequate. And, secondly, the proposed survey would take into account and relate all pollution factors, and thereby permit development of procedures for the preparation of a comprehensive pollution control plan involving radioactive contamination. This survey project was undertaken and it ran for a period of about 2 years.

The problems which we have dealt with go far beyond keeping an eye on the effect on the river below the plant. I will mention just a few to indicate the ramifications and complexities of keeping potential radioactive contamination from waste disposal under control. I am sure some of the things I will mention have been discussed in detail by previous witnesses from the General Electric Company at Hanford. However, their place in my discussion is to bear out the need for state participation and support. Without such, the work would be immeasurably more difficult of accomplishment.

1. Downstream water treatment plants were carefully studied to determine if their processing would concentrate otherwise minute concentrations of radioactive materials and create hazardous levels in the municipal supplies.
2. Waste disposal from these water treatment plants had to be given special consideration.
3. The development of large quantities of return flow from the Columbia Basin Reclamation Project which enter the river above the plant had to be closely observed. An increase in certain dissolved minerals and turbidity could seriously affect the stringent quality requirements of the reactor cooling water; and subsequently cause an increase in level of activity in the river.
4. The installation of a pulp and paper mill on the river below the Plant required consideration of the possible concentration of activity through their processing with resultant objectionable levels in their products.
5. Irrigation with water from below the plant directed attention to possible build up of the radioactivity in plant life.
6. The construction of Priest Rapids Dam on the river immediately above the plant required attention to controlling turbidity which was especially significant as this is primarily an earth-fill structure.
7. Continuing study is being given to the effect of increase in temperature on the salmon fishery; and the build up of activity in the resident game fishery.
8. We assisted in development of a plan for operation during an emergency. It extends to every water user including several municipal and private domestic supplies, industries, recreational areas, stock watering,

irrigation, navigation, and hydro electric installations.

It was anticipated in the formation of the Columbia River Advisory Group that the representatives would obtain valuable training, become familiar with the radiation control program at Hanford, and that they would assist the AEC and its contractor in long range programs. All of these things have been fully realized, and as I note this I should point out that this can be attained only through a full spirit of cooperation.

Further, it is important to note in observing on the satisfactory experience with the Columbia River Advisory Group, that it was not an official or legal body. It would be necessary for the states or the Public Health Service to act independently on any formal action. However it has demonstrated that federal-state cooperative approach is fundamental regardless of possible legally established mechanisms.

Aside from the CRAG activities the State of Washington is cooperating with the Commission's Inspection Division now located at Hanford. We have found this activity to be beneficial as training for our people; as a nucleus around which to develop a program; and as a means of learning as to the extent and distribution of isotope use in our State. This cooperative activity is ever increasing as the number of licensees gains and the federal-state resources permit more frequent and thorough inspections. It has occurred to us that it would be desirable to have a procedure for the applications for license referred to the Inspection Division and the State for review and investigation before the license is granted.

As you look ahead to what must be done to keep radiation hazards under control it seems imperative to plan on use of substantial resources of state and local government - especially on this matter of radioactive waste disposal.

This is just one more of the increasing complexities of man's environment; and as with all others, we have found it necessary to consider the inter-relationships. As I pointed out in connection with our experiences with the Hanford Operations, on the single matter of radioactivity being an added factor in water pollution, we had to, of necessity, extend our concern to many things. These were day to day responsibilities and functions of state and local agencies, and they cannot be brought to bear effectively on a situation unless these groups are involved.

There will be accidents or emergencies despite the careful planning to preclude them. At these times such precautions as containment for reactors, remoteness of plant locations and warning devices may not provide necessary protection. Other measures will have to be assembled on the scene to combat unforeseen developments. Waste disposal by radioisotope users occasionally involves municipal sewer systems. This brings in consideration of the safety of maintenance personnel, the ability of waste treatment works to handle the m terial and the need for training. These are just further illustrations of the need to plan on utilizing all resources normally associated with controlling our environment.

The handling and eventual disposal of a variety of wastes from radioisotope users in medicine, research, and industry is destined to become of everyday concern to states. In Washington of this moment several users are holding waste materials - some awaiting sufficient decay of shorter lived materials for simple disposal within limits and others have no suitably available method or qualified recipient for disposal.

Aside from the major problem of high level long lived materials, potentially there appears a need for local controlled burial areas for low and intermediate

level activities with decay periods critical for a relatively few years. Such disposal may in many cases be preferable to disposal to sewers or waterways, would be appropriate for contaminated glassware and other dry forms, and could afford more complete isolation and control.

Such burials would need to be closely controlled under a state approval and licensing system in suitable reserve areas. In the case of sources in public institutions and agencies, it might even be handled as a direct state function or service. Again the team approach using federal, state and private technical resources in establishing such a program would be a key factor.

As you may set a course for realignment and distribution of responsibilities it is believed the following are some of the important and basic considerations. At this point I quote extensively from a paper "Problems Facing State Agencies in Handling Treatment and Disposal of Radioactive Waste" which I presented at the Second Nuclear and Engineering Science Congress. This paper was coauthored by E. F. Eldridge, C. M. Everts, Jr., and H. C. Clare.

Assuming the states are to pick up an extensive role there is nothing in this problem of radioactive waste disposal which is basicly new. However its solution will require more team work than other problems to date. The states are short on competence to handle the technical complexities and the public does not favor the prospect of industry evaluating its own problems and policing itself. For the team approach to work productively, industry must recognize the jurisdiction and responsibility of the states and the states must be as practical and reasonable as the situation will possibly allow.

With respect to development of state legislation, it appears extremely important to have uniform laws at least on the technical phases of the problem. Because of the extensive activity in this area it is important to establish: (a) what constitutes a good uniform law on the subject under present circumstances,

and (b) how far should state statutes go to control a situation which is presently in the hands of the federal government.

The training of personnel for activity in the field of atomic energy is a prerequisite for a sound program in the field of radioactive waste disposal. In this area the need is for: (a) coordination of training at the federal level; (b) the recruitment of qualified personnel by pollution control agencies; (c) sound financial support for training programs, and (d) opportunity to gain realistic experience in the program.

It is generally recognized that any successful program must have adequate financial support. This is certainly the case with any program for radioactive waste disposal. Necessary expenses for personnel, equipment, laboratory facilities, and operation are especially high in this field. Unfortunately such programs are usually in competition with other programs for support and money.

Undoubtedly rapid development and complexity of the problem and the requirement for special training has been a significant deterrent to the states in developing interest and participation. This is not the usual situation. Previously the staffs of the states have been able to pick up new assignments more or less in stride. With a relatively minor assignment in this field, over the past several years, the states have had to relegate the related programs to a secondary position and training efforts have suffered accordingly. In spite of these difficulties, however, there is good reason for the belief that the attitude and cooperative hand of industry, and the control program of the Atomic Energy Commission will allow the states sufficient time to attain competence and resources if they intensify their efforts immediately.

To assure that this will come about it would be important that the federal policy be toward the end of encouraging and directing the states to assume their

share of the responsibility. As it is now it seems there is too often an excuse for states to remain inactive or to not know which way to turn. In other words it seems that your task is one of assuring that each agency discharge its normally related responsibilities and coordinate its activities with others in any manner that will permit the most rapid development of the beneficial uses of atomic energy and at the same time provide for the necessary control of the radiation hazard.

In conclusion it is important to note that in so far as the whole population is concerned, control of the hazards from radioactive waste disposal is a very direct means of assuring the most complete application of the beneficial uses of atomic energy. Based on the consensus that an individual's lifetime dosage must be limited, then it follows that the prevention of any exposure in his environment from waste discharges or any unnecessary source will enhance the direct beneficial uses of diagnoses, therapy, power generation, measurements, or research.

Note: A survey of the states' interests and activities on this problem was conducted in connection with the preparation of the aforementioned paper presented at the Second Nuclear Congress. Although these findings are a year and a half old it is believed they will provide some useful information, so they are attached to this statement as a supplement.

Problems Facing State Agencies in Handling Treatment and Disposal of Radioactive Wastes[1]

EMIL C. JENSEN,[2] E. F. ELDRIDGE,[3] C. M. EVERTS, JR.,[4] and H. C. CLARE[5]

(Presented at Second Nuclear Engineering and Science Conference, March 11-14, 1957, Phila, Pa.)

Inventory of problems, viewpoints, resources, and requirements of states relating to control of radioactive wastes and materials as sources of contamination of the environment and radiation exposure of the general public. Intended to serve as a basis for effective integration of related activity on control of radiation hazards.

INTRODUCTION

STATES will face a grave challenge in providing control of harmful radiation exposure in our environment. Their need is to acquire the resources and a period of time in which to develop competence. Their experience to date in this field is considerably short of that which will be required as they take over a major share of the responsibility. The radiation problem associated with the use of radium and x-ray, prior to the recent extensive developments in atomic energy, commanded the attention of relatively few people. And, during the past 10 to 15 years the states have had very little responsibility and opportunity to become familiar with the factors relating to control of radiation exposure.

The authors of this discussion fully recognize the potential benefits of atomic energy. The goal is therefore to attain radiation protection with minimum restriction on the early development and utilization of these benefits. With the intent of furthering this goal we offer advice and guidance to those who are responsible for assuring the safety of our environment.

This discussion cannot be limited exclusively to problems of radio-active waste treatment and disposal. It must in some measure deal with any source of radiation or factors which will result in contamination of the environment and exposure of the public. Also, the discussion will reveal some of the states resources and status of activities pertaining to control.

PROBLEMS AND CHALLENGES

General

In most discussions on the problem of radiation hazard control emphasis is usually placed on two factors: (1) the anticipated increase in the use of nuclear materials—illustrated for example by reference to the creation of millions of curies of new fission products each year by power reactors; and (2) the unknowns with respect to effects of radiation on human beings. There might well be a greater factor from the standpoint of state government. Of equal concern and often overlooked is the magnitude and complexity of the task faced by state governments during the current transition stage when the emphasis on atoms for peace shifts the responsibility for development from the federal government to private industry. As this occurs the states, in discharging their traditional responsibility for protection of the environment, will have to assume a major role in the program for radiation protection. There is a real question as to the readiness of many states to accept this challenge.

The records show that the Atomic Energy Commission has achieved a remarkable degree of success in the control of radiation thus far, especially since

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it was accomplished during a most pressing developmental stage. Will these conditions continue to hold true however as competitive industries pick up the reins and the industrial economics enters the picture? The federal government has extensive opportunity at the present time through licensing and inspection programs to provide controls, but can such be effective as the use of nuclear materials increases and extends to all corners of the nation? Such, then, is the problem facing the states.

Specific

Many new things must be considered in relation to utilization of water courses for radioactive waste disposal. They at times will require a complete change in the usual line of thinking. Some examples:

1. Radioactive characteristics of a waste may demand more than a million times the dilution necessary to nullify other pollutional characteristics. One billionth of a part per million of strontium 90 would produce tolerance levels.
2. The food chain comes in as a prominent factor. Plankton and algae may absorb the radioactive nutrients directly from the water. Bottom animals feed on this material, fish feed on the animals, and at the end of the chain is man. Of particular note is that the plant life has been measured to accumulate or concentrate the radioactivity to a level of over 1000 times that in the surrounding water, and that this concentrating effect continues by selective deposition of the radioactivity in certain parts of the fish.
3. Thermal and density conditions will require more specific study of factors affecting stream flow patterns and the dispersion from outfalls. This will be especially important with material having a short half-life. Good initial mixing and dispersion of such material will be a major factor in allowing maximum utilization of the receiving water course.
4. The hazardous characteristic of a waste may carry practically undiminished throughout the entire length of a stream. Time will be the only factor affecting any reduction in activity of material remaining in suspension.
5. Radioactivity is removed from solution by certain sediments. This transfers the problem to a consideration of the factors governing their transportation. This may result in heavy accumulation of activity in sections of the stream bed during low flow, and the flushing of high concentrations during floods.

Excellent discussions related to this phase of the problem are given[1, 4, 5, 6] in papers presented at the first sessions of this Congress in Cleveland in 1955.

The quality of water supplies for nuclear energy plants will be of concern and will represent a means of controlling radiation. Dissolved and suspended matter, especially certain mineral elements, may become irradiated. This will require that attention be given to upstream discharges from such as mining operations, return flows from irrigated areas, and certain industrial plants to control the concentrations of mineral elements.

Disposal of radioactive wastes into community sewer systems and treatment works will present some problems of concern. It is believed these will be small in the total picture because the larger sources of radioactive wastes must be handled independently. The areas of concern will be concentration in the plant and animal life in the sewer, removal efficiencies at the treatment works, possible concentration in some units of the treatment works, effects beyond the outfall, and personnel safety. Primary activities will include efforts to eliminate or prevent the sources, routine monitoring, and possibly adjustment of treatment processes. Related problems have been discussed in numerous articles;[1, 6, 7] and are pertinent to the matter of measuring radioactivity in water and factors governing removal in treatment processes.

The evaluation of a radioactive water pollution problem requires knowledge of natural background activity and the characteristics of the activity present, and information on the kinds of radioisotopes from the source of contamination. The work associated with this evaluation is immense, and of more importance is its complexity and the fact that many of the involved procedures are yet to be developed or refined. It will definitely be a responsibility of the sanitary engineer to join with the team in accomplishing the work as he did in connection with other waste disposal problems.

Land and sea burial practices for active wastes are not without concern. They are not a case of out of sight out of mind. Solidified and encased wastes can be buried in only very limited areas of the sea floor. In the present practice, the dense concrete drums or blocks do not settle into bottom muds and become permanently embedded and covered. Rather, sediment deposit and accumulation on most of the ocean floor is very light and the radioactive packages will be subject to eventual disintegration.

Studies have shown that there are very definite limitations and many things yet to learn concerning the use of the oceans for disposal of large quantities of liquid waste.[10] It is the consensus that apparent large dilution ratios are not generally available because of lack of vertical mixing. Valleys or depressions in the ocean floor where there is little movement of the water mass present a possibility for dense waste disposal; however as these would be used over a

period of time, the effect of thermal currents would have to be considered.

Ground disposal systems for both liquid and solid wastes present a completely different problem than with other wastes because of the long life and stability of some wastes. The time element may now be hundreds of years rather than days or months. This brings forth for prominent consideration the often disregardable factor of ground water movement. Some wastes will have to be permanently contained which will demand unprecedented attention to durability of encasement structures. Others will require study of the fixation ability of the subsoils. And some scheme will have to be devised for permanent exclusion of the public and any human activity in such cases. To provide for monitoring over a period of hundreds and perhaps thousands of years will be a considerable undertaking.

RESOURCES AND STATUS OF STATE PROGRAM

An inquiry was recently sent to all State Sanitary Engineers (Directors of the Divisions of Engineering and Sanitation of the State Health Departments) and Directors of the state water pollution control agency where such were separate from the Department of Health. Fifty of 57 questionnaires were returned. The following summary represents 44 of the states and the territories of Alaska and Hawaii.

Admittedly there are many shortcomings in using this approach to evaluate a situation, especially one in which there is so much initial variance. Differences in the interpretation of a question often leads to a completely different report on two like situations. And additional error occurs in trying to interpret and summarize the answers. However, it is believed that some significant and helpful findings were attained from this survey.

Of first concern was an appraisal of the sincerity of interest or attitude of state government on the problem and a verification of such by evidence of their activities relating to legislation and control. The replies revealed that

1. Twenty-two states were placing complete reliance for the time being on existing authority within Public Health and Pollution Control laws.
2. Only 7 had specific legislative authority. Four of these were statutory and 3 through regulation of existing authority.
3. Fifteen indicated measures that were being presented to their legislature or that studies were actively underway on study and preparation of legislation.
4. Some of this latter group were carrying on programs based temporarily on existing authority.
5. Sixteen states apparently had no program or activity. With a few this can be interpreted to mean that there is a complete lack of interest; with the others its a case of either no time to give or no problems demanding attention.
6. Sixteen reported minor activities including a little work on background surveys, occasional consultations, and some work with AEC on inspection of radioisotope users, and participation in national air sampling network.
7. Twelve reported fairly extensive programs including elaborate stream surveys, participation in site selection for nuclear energy plants, inspection and registration of users of radiation, etc.

On the subject of standards for waste discharges, it is of interest to note that the usual independence of state thinking and attitude was lacking. There was a predominance of dependency on the health and safety regulations of AEC or the NCRP recommendations.[9,10] Many had little or no comment, indicating they had not arrived at this point in their considerations. With those who had specific comment, the trend was to only very general coverage in any law or regulation, and a realization that the matter should be approached cautiously and no definite steps should be taken until more is known on the subject. There was also considerable recognition of the need for uniformity that would be assured through use of the AEC regulations.

The replies indicated extensive utilization of consultation services from the AEC and their contractors, the PHS, and the Universities and Colleges. A few indicated representation on committees with these agencies and reported such to be an excellent method for exchange of views.

On the subject of training, 33 had availed themselves of the various training opportunities, especially those conducted by the Public Health Service. Of the 33 it appeared that an all-our effort had been made by about seven states. This included graduate training for key personnel and short course training for all other persons having any connection with the program including persons from local health departments. Answers from the other 23 indicated that the extent of training was quite variable, but they did at least reveal there was recognition of the need, and an effort was being made.

The provision of laboratory services seemed to have a low priority. Ten reported having such facilities available. Three appeared to be adequately equipped for a complete program. The other 7 had very minimal facilities, usually set up in connection with occupational radiation protection activities or background

level determinations for water supplies and stream surveys. However to this list were added 10 states that reported definite intentions to provide laboratory facilities soon.

The assignment of manpower to the activities, as might be expected, follows the pattern reported previously regarding the extent of actual programs. However, the details on this point give a little more indication of the intensiveness and competence of the state activities. Seventeen reported having personnel actually assigned specific responsibilities. However, in most cases it was a very minimum consisting of 1 or 2 persons part-time. Twelve other states indicated that regular employees handled the work as needed. The following are a few of the more significant problems or situations reported as being of concern to the states:

1. The radiation hazards from within military or other classified installations.
2. Desire for authorities to set levels of concentration which are to be regarded as radioactive contamination.
3. The need for knowing all sources of radiation within a state to permit proper evaluation of any problem.
4. Need for an agency to which pollution control authorities may turn for technical advice.
5. Unfounded and unwarranted fears and overconcern on the part of both the public and government agencies.
6. Due to relatively high cost of electrical power, some states anticipate extensive development of power reactors and related process facilities with a result that waste disposal may seriously endanger the ground water, their main source of supply.
7. The need for a "Standard Analysis Service" to check laboratory procedures and assure uniformity of methods and interpretations.
8. Some were concerned on the practice of using radioactive tracers in logging oil production.
9. There were expressions of concern on the indecision with respect to federal versus state jurisdiction; and the lack of agreements of experts on the genetic hazard.
10. Probably new in this industry, was a cross connection between a city water supply and the cooling system of a reactor.
11. Wastes other than radioactive wastes were of concern. Chromium from cooling water from gaseous diffusion type plant and fluorides from uranium refining were reported.
12. And one state believed more should be known regarding transportation of radioactive materials having disaster implications.

From a final question, it appears that there is actually very little activity among the cities on the control of radioactive waste discharges to sewer systems. Five large cities were reported as having control through provisions in their sewer use ordinances and having monitoring programs established.

COOPERATION IS EFFECTIVE

The approach to this problem possesses nothing basically new; however, it will require more teamwork than other problems to date. The states are short on competance to handle the technical complexities; and the semblance of industry evaluating its own problems and policing itself does not set well with the public. For this team approach to work productively it must be truly a two-way street. The industry must recognize the jurisdiction and responsibility of the states; and the states must be as practical and reasonable as the situation will possibly allow.

The authors of this paper have experienced the value and workability of such a co-operative effort. In the early stages of operation of the AEC's Hanford Works on the Columbia River, adjacent communities developed concern over the safety of the installation and possible effects of the operations on the river and the atmosphere. The water supplies for two major cities a short distance downstream were of greatest concern.

The Public Health and Pollution Control authorities of Oregon and Washington having responsibility and appreciation for the concern of the communities approached the management of the installation on the matter. They were most receptive and asked for suggestions. As a result a permanent committee of representatives of the two states was established. It is known as the Columbia River Advisory Group.

Following security clearances we held periodic meetings with the AEC and contractor personnel and were conducted on plant and site survey trips. They included thorough briefing on the industrial processes and activities related to waste disposal and radiation control. We soon found ourselves in a position to make public statements with confidence to the effect that the operations were not creating a hazard in the river or in the atmosphere. This was of course much better received by the communities than had the AEC or its contractor made the statements.

Our meetings now are on a biannual basis and are one to two days in length. Our main interest at this time is to follow their research and developmental work.

This has been a most profitable undertaking. We have had realistic experience on a scale at least equal to large power reactors. We have followed extensive basic research related to many problems in radio-active waste disposal. We have assisted them by advising on design and operation of water treatment facilities and detention basins for the pile cooling water; and by

having knowledge and control of upstream conditions affecting the quality of the river. This was most important to them because of their bearing on the problems of corrosion and irradiation in the reactors.

STATE ADVISORY COMMITTEE TO AEC

The Atomic Energy Act of 1954 has set the stage for peaceful use of atomic energy; but at least for the present retains control for radiation protection in licensed facilities, at the federal level. In its administration of the law, however, the Atomic Energy Commission has made a sincere effort to consult with the states on matters of radiation protection and initiated a program which will ultimately provide the basis for a harmonious Federal-State relationship in the field of radiological health.

Of concern to many states are the provisions of some of the regulations promulgated by the Commission. It should be pointed out, however, that those regulations dealing with both licensing and radiation protection, were carefully devised and represent the best thinking on the subject available today. They were subsequently submitted to the states for comment, and were discussed thoroughly with the Commission's Advisory Committee of State Officials. This Committee has been working with the Commission for more than a year in an effort to bring about the mechanism for close cooperation between the Commission and the states on matters of mutual interest in the field of atomic energy. There are such a variety of state agencies responsible for radiation protection that one wonders how the Atomic Energy Commission could carry on its activities within a state without having some one agency designated as a local coordinator. The liaison work of this Committee, therefore, should be followed closely by the states both now and in the future.

IMMEDIATE NEEDS

With respect to development of State legislation, it appears extremely important to have uniform laws on the subject at least on the technical phases of the problem. Because of the extensive activity in this area it is important to know: (1) what constitutes a good uniform law on the subject under present circumstances, and (2) how far should state statutes go to control a situation presently in the hands of the Federal government.

The training of personnel for activity in the field of atomic energy is always a prerequisite for a sound program in the field of radioactive waste disposal. In this area the need is for (1) coordination of training at the federal level, (2) the recruitment of qualified personnel by pollution control agencies, (3) sound financial support for training programs, and (4) opportunity to gain realistic experience in the program.

It is a foregone conclusion that any successful program must have adequate financial support. This applies equally well to those concerned with radioactive waste disposal. Personnel, equipment, laboratory facilities, and operation expense are significantly high in this field; and usually, are in competition with other programs for support and money.

CONCLUSIONS

Although somewhat inconsistent with the softening note which will follow, it is important to recognize that atomic energy will have an unprecedented impact on the sanitary engineering profession as it has had on every other profession it has touched. Everywhere one turns, with national defense, power generation, medicine, education, and agriculture, it is challenging the greatest minds. In sanitary engineering it may be more of a two-fold involvement. There is the problem of controlling the radiation hazard as discussed in this paper, and then there is the definite possibility of developing beneficial applications to further the investigations and solutions of existing problems.

Unfortunately, the axiom—where there is a will there is a way—may not apply in this situation. The lack of resources within the states, or their not being fully geared to handle the problem, is not due to lack of willingness. Budgets are as usual a factor; but the biggest deterrent has been the rapid development and complexity of the problem and the requirement for special training. This is not a normal situation. Usually the staffs have been able to pick up new assignments more or less in stride. With the relatively little work in this field, the states have had to relegate the related programs to a secondary position and training efforts have suffered accordingly.

Fortunately, it is believed, the rate of development, the attitude and co-operative hand of industry, and the control program of the Atomic Energy Commission will allow the states sufficient time to attain competence and resources if they intensify their efforts now.

Seldom, if ever, has there been a more favorable situation. Those responsible for protection and promotion of public health as they perform their task of controlling radiation hazards, can be assured that at the same time there will be developments contributing tremendously to the advancement of their goals. They can have full confidence that they will not have to go through the procedures of yesteryear wherein a scoring system had to be used to rate the safety of environmental situations, such as in water supplies and restaurants, to draw the public in for support. With radiation, the public is already on their side, maybe too much so. In addition, an extremely wide variety of training opportunities are available.

With this problem it is very real that succeeding generations could claim they inherited it from their forefathers—those even 5000 years from now. States must pick up their share of the load. They must be alert, resourceful, and particularly be practical in their approach. They must use all of the technical information and experience at their command to make a careful evaluation of each problem so that its impact on both present and future generations can be determined. They must also consider their own readiness and the resources available which will enable them to arrive at reasonable and practical solutions to problems of radioactive waste disposal.

Most sincere appreciation and thanks is accorded to the State Sanitary Engineers and Directors of State Pollution Control Agencies who so promptly and willingly furnished information for this discussion.

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Representative HOLIFIELD. Our next witness is Mr. A. E. Gorman, who is to report on the Geneva Conference on International Law of the Sea.

Mr. Gorman, will you please come forward at this time?

You have fairly long testimony here, Mr. Gorman, so I will ask you, if you will, to summarize it; and we will include it, of course, in its entirety in the record.

STATEMENT OF ARTHUR E. GORMAN,[5] ORMOND BEACH, FLA., CONSULTANT, DIVISION OF REACTOR DEVELOPMENT, U.S. ATOMIC ENERGY COMMISSION

Mr. GORMAN. Mr. Chairman, last spring it was my pleasure to represent AEC as an advisory member of the U.S. delegation to the International Conference on the Law of the Sea at Geneva.

There have been previous conferences on the law of the seas, at which the number of nations represented was perhaps in the order of 35 or 40, but at this United Nations conference there were 86 nations represented. There was a great deal of reflection of the newer political philosophies and economic status and ambitions of the various nations.

Of the 73 articles which the International Law Commission had presented to the conference for debate and discussion, only two referred to atomic energy activities. One was article 27, on the freedom of the seas, and the other one was article 48, on pollution of the high seas.

Freedom of the seas was discussed both in Committee No. 2, which was assigned the responsibility for these two articles, and also in

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Education: Haverhill Public Schools; B.S. Worcester (Mass.) Polytechnic Institute, 1917.

Positions held: Assistant chemist, city of Worcester, 1916–17; assistant and associate sanitary engineer, U.S. Public Health Service, 1917–24; chief sanitary engineer, city of Chicago, 1924–27; engineer-epidemiologist, sanitary district of Chicago, 1928; director, sales promotion, Wallace & Tiernan Co., 1929–30; engineer of water purification, department of public works, 1931–41, and assistant city engineer, 1942, city of Chicago; director, water division power branch, 1942–43, and Office of War Utilities, U.S. War Production Board, 1943–45; consultant, U.S. Public Health Service, 1945–46; director, public services division, land and public services branch, National Housing Agency, 1946–47; acting, and later director, land and public services branch, Office of Housing Expediter, 1947; sanitary engineer, Division of Engineering, 1948–53, and chief, sanitary engineering, Reactor Development Division, 1953–57, inclusive, U.S. Atomic Energy Commission.

Professional societies: Member, American Society of Civil Engineers; life member, American Water Works Association; fellow, American Public Health Association; diplomate American Academy of Sanitary Engineers, 1958; member, Federation of Sewerage and Industrial Waste Association, 1946–53; Illinois Society of Engineers, 1930–42; Inter-American Society of Sanitary Engineers; Washington Society of Engineers, 1953–57; Western Society of Engineers, 1927–42.

Registered professional engineer: State of Illinois, District of Columbia, 1953–57.

Professional honors: American Water Works Association—John M. Diven Medal (1927); Illinois Society of Engineers—Corecipient, annual medal (1933); Department of Defense, U.S. Army—Certificate of appreciation for outstanding civilian services (1951); National Civil Service League—Merit citation (1956); U.S. Atomic Energy Commission—Outstanding service award (1956).

Publications: Author and coauthor of numerous special reports and over 150 published technical papers on: Mosquito control, water supply on interstate carriers, railroad coach yard sanitation, water supply and purification, economics of metering, public health engineering, waterborne outbreaks of disease, disposal of radioactive and toxic wastes, site selection and environmental sanitation in the atomic energy industry.

Consultant to: Reactor Development Division, U.S. Atomic Energy Commission; Division of Water Supply and Stream Sanitation, U.S. Public Health Service; lecturer on environmental problems in the atomic energy industry, Robert A. Taft Sanitary Engineering Center, U.S. Public Health Service, Cincinnati, Ohio; technical adviser on disposal of radioactive wastes to U.S. delegation; United Nations International Conference on the Law of the Sea, Geneva, Switzerland, 1958; member, expert advisory panel on radiation, World Health Organization.

three others of the five working committees. This indicated a great deal of concern by nations of the world on alleged interference with the freedom of the seas by nuclear testing. Their case was presented on two scores. One was contamination of the ocean by fallout of radioactive debris and the other was interference with navigation and normal rights.

The United States and United Kingdom delegates made a strong effort to have article 27 referred to a technical study group of the International Atomic Energy Agency. There seemed, however, to be a good deal of resentment to such a proposal among certain members of the conference with the inference that an effort was being made to take away from jurisdiction of the conference features of the atomic energy industry which were related to the freedom of the seas.

I will not attempt to go into the voting on article 27, but will move on to article 48, which dealt with pollution of the seas. This article is more directly concerned with the disposal of wastes—a subject this group is most interested in.

Paragraph 1 of article 48 dealt with oil pollution. There were two other paragraphs submitted by the International Law Commission for debate and action by the conference. One, paragraph 2, read:

> Every state shall draw up regulations to prevent pollution of the seas from the dumping of radioactive wastes.

The other paragraph read:

> All States shall cooperate in drawing up regulations with a view to preventing pollution of the seas or air space above them resulting from experiments or activities with radioactive materials or harmful other agents.

In the case of this article, as with article 27, the U.S. and the U.K. delegates, recognizing that there was a vast area of technology involved, endeavored to refer the whole matter to the International Atomic Energy Agency. This action really ran into a hornet's nest. There was extremely strong objection on the part of delegates from the Afro-Asian, Latin, and even the Western European nations in NATO. They took the position that pollution of the high seas must be strictly forbidden; that no radioactive material whatsoever should be disposed of at sea. There was no reference to high-level waste, low-level waste, or any quantitative relationship to kinds or volumes of wastes.

After much intensive debate the vote of the U.K.–U.S. resolution to refer the subject to the IAEA was 30 for, 29 against, with 6 abstentions. With such a close vote, it was, of course, obvious that in plenary session, this would be defeated.

Therefore, a compromise plan was worked out by the chairman who appointed a subcommittee to resolve differences. Finally, an extra article with two paragraphs was put back into the document, while the amendments proposed by United States and United Kingdom and approved by the margin of one vote was retained.

The two articles added were:

> 1. Every state shall take measures to prevent pollution of the seas from the dumping of radioactive waste, taking into account any standards and regulations which may be formulated by the competent international organizations.
>
> 2. All states shall cooperate with the competent international organizations in taking measures for the prevention of pollution of the seas or air space above, resulting from any activities with radioactive materials or other harmful agents.

In the plenary session, this article was approved by unanimous vote.

In conclusion, as a result of my observations of the debate and actions at Geneva, it is obvious that a real task lies ahead of the IAEA under the terms of the U.S. and U.K. resolutions on both articles 27 and 48, even though the conference on the law of the seas adjourned without international agreement.

Since ocean disposal, certainly of high-level radioactive wastes, could bring about international complications, one might question if large sums of money should be spent to study the oceans merely for the disposal of such wastes. Research and development funds might better be allocated to evaluating problems of disposal of low-level radioactive wastes at sea, safe ultimate methods of disposal of high-level wastes on land, or in the extraction from waste materials long-lived nuclides which are most significant as radioactive contaminants of man and his environment.

There was no discussion at the International Conference on the Law of the Sea of the problems which nuclear-propelled vessels might introduce in relation to pollution of the seas. This is an area which needs special attention at subsequent conferences of this kind, and it seems sure it will there be discussed.

As a matter of fact, at a United Nations International Labor Conference, which was held after the Conference on the Law of the Seas adjourned, resolutions were introduced referring to the use of atomic energy for propulsion of ships and calling for the evaluation of possible hazards to workers in the shipping industry, looking to the protection of them against risks in question.

Once radioactive materials are released to the seas, there is little likelihood of their recovery. It is worth recalling that the oceans and seas occupy about two-thirds of the earth's surface. They constitute an environment about which information is relatively sparse compared with knowledge of man's land environment.

The extent to which future generations will obtain food and other resources from the sea is unpredictable. We are familiar with damage and destruction of land assets by careless and uncontrolled exploitation. It would seem prudent, therefore, to proceed with caution in releasing high-level radioactive contaminants to the ocean.

The extent to which important national defense instrumentation at critical points may someday be sensitive to increase in background radiation induced by disposal of radioactive materials to the ocean or harbors at their approaches may be worthy of some consideration.

It is important that the atomic energy industry be represented by technical staff at all international conferences where matters of interest of concern to the industry are scheduled or liable to be discussed. Because of the rapidly changing technology of the industry, position papers prepared for the delegates should be prepared with assistance and advice from nuclear technicians familiar with the atomic energy program, especially in channels of research and development. Disposal of radioactive wastes to the ocean is a subject of great concern to all nations.

I was surprised at the depth of this concern at the Geneva meeting.

It is a matter involving policy at high levels, both within the atomic energy industry and in international relations.

Representative HOLIFIELD. Thank you very much, Doctor.

(Mr. Gorman's formal statement follows:)

THE 1958 INTERNATIONAL CONFERENCE ON THE LAW OF THE SEA

Arthur E. Gorman, Ormond Beach, Florida.
Consultant, Division of Reactor Development
U.S. Atomic Energy Commission

For Presentation at Public Hearings on Industrial Radioactive Waste Disposal; Special Sub-committee on Radiation, Joint Committee on Atomic Energy, Congress of the United States, Washington, D.C. - February 3, 1959.

The disposal of radioactive wastes to the sea was the subject of sharp and revealing debate at the United Nations Conference on the Law of the Sea held at Geneva, Switzerland, February 24 - April 28, 1958. At this conference 86 nations were represented.

When the existing laws of the sea were adopted many years ago, in the order of one half this number of nations participated, and the percentage representation of western bloc nations was high. The broader base of representation at Geneva reflected significant changes which have developed in the political philosophy, economic status, ambitions and affiliations of both the older and newer nations. The orthodoxy of other generations was laid open to re-examination and appraisal in the light of the new freedoms and alignment of nations and the advance of technology in the many sciences.

The agenda for the Conference called for discussion and action on 73 Articles presented in a Report of the International Law Commission. Only two of these Articles: Article 27--Freedom of the High Seas and Article 48--Pollution of the High Seas dealt with uses of atomic energy; but debate on them was fully as intense as in treatment of other highly controversial articles.

This was the first time problems arising from the use of atomic energy were brought before a law of the seas conference. Like an iceberg, they have greater depth than is now generally realized, based on our current knowledge of the industry's potentialities. Most certainly, they deserve serious consideration as the use of atomic energy expands on a world-wide front.

While delegates were quite willing to refer strictly technical matters to an international atomic energy agency for investigation, it was abundantly clear that this conference was unwilling to release from the jurisdiction of the law of the sea, judgments as to effects of atomic energy operations on the seas, and uses of the seas by various nations. One may, therefore, expect that international policies and problems involving use of the sea for transport of nuclear propelled facilities or disposal of radioactive wastes will be dealt with at high levels in government.

Unfortunately, in the Plenary Sessions no international agreement was reached on revision of the existing laws of the seas. The debate and the record of voting in working committees served, however, a real purpose. No one who attended the conference could avoid the conclusion that the atomic energy industry and all who guide its progress and destiny have a deep and continuing obligation to evaluate the impact of its operations on the oceans and seas of the world.

For purposes of organization the two articles in the Report of the International Law Commission, dealing with atomic energy, were assigned to Committee II on the Regime of the Sea for debate, action, and report to the conference for final consideration in plenary sessions. This was one of five working committees.

ARTICLE 27--FREEDOM OF THE SEAS

Delegates from many nations took the stand that under existing national law testing of nuclear weapons was a violation of the freedom of the high seas. It is significant that this position not only was debated spiritedly before Committee II, but also was dealt with forcefully in the general remarks of delegates serving on three of the four other working committees. Nations whose delegates declared testing of nuclear weapons was in violation of international law or opposed such testing for other reasons were: Albania, Bulgaria, Burma, Ceylon, Czechoslavakia, Japan, India, Iran, Japan, Nepal, Rumania, Ukraine, Union of Socialist Republics (USSR), United Arab Republic (UAR), and Yugoslavia. The pressure in debate was such that it resulted in the following resolution adopted on April 27, 1958, in the Plenary Session, acting on the report of Committee II:

> The United Nation's Conference on the Law of the Sea
> Recalling that the Conference has been convened by the United Nations in accordance with resolution 1105 (XI) of February 21, 1957,
> Recognizing that there is a serious and genuine apprehension on the part of many States that nuclear explosions constitute an infringement of the freedom of the seas,
> Recognizing that the question of nuclear tests and production is still under review by the General Assembly under various resolutions on the subject and by the Disarmament Commission, and is at present under constant review and discussion by the Governments concerned,
> Decides to refer this matter to the General Assembly for appropriate action.

In Committee II a number of amendments to Article 27 were submitted. After full discussion and debate amendments by Brazil, China, France, Mexico, the Netherlands, Poland, and Spain were withdrawn. Joint amendments by Albania, Bulgaria and USSR, and by Czechoslavakia, Poland, USSR and Yugoslavia together with separate amendments by Peru, Portugal, Poland, and Yugoslavia were defeated. Only two amendments were adopted: one by Mexico and the other by the United Kingdom (U.K.).

As amended, Article 27 carried in Committee II by a vote of 43 for, 4 against. There were 13 abstentions--mostly nations associated with the Soviet bloc. In the subsequent Plenary Session of the Conference this same Article, reading

as follows, was adopted by a vote of 71 for, none against, and one abstention:

ARTICLE 27--FREEDOM OF THE HIGH SEAS

The high seas being open to all nations, no state may validly purport to subject any part of them to its sovereignty. Freedom of the high seas is exercised under the conditions laid down by these articles and by the other rules of international law. It comprises, inter alia:

1. Freedom of navigation;
2. Freedom of fishing;
3. Freedom to lay submarine cables and pipe lines;
4. Freedom to fly over the high seas.

These freedoms, and others which are recognized by general principles of international law, shall be exercised by all States with reasonable regard to the interests of other States in their exercise of the freedom of the high seas.

The delegates who opposed nuclear weapons tests on the high seas and objected to fallout of radioactive material resulting from these tests did not appear to realize that fallout contamination of the waters of the high seas resulted from land tests as well as tests at sea. A timely speech by Commissioner William Libby of the Atomic Energy Commission at nearby Luzanne, Switzerland, on March 27, 1958, emphasizing this fact, was given wide publicity with illustrations in Geneva papers. It seemed, however, to have had little effect on the position taken by delegates of even non-Soviet controlled nations. Of the two issues (1) banning of nuclear tests as a violation of the freedom of the seas, and (2) preventing contamination of the high seas by radioactive fallout; the former, by a large degree, appeared to be the more important to the delegates.

ARTICLE 48--POLLUTION OF THE HIGH SEAS

Paragraph (1) of the International Law Commission's Report dealt with pollution of the seas by oil. Paragraphs (2) and (3) dealt with pollution by radioactive materials and read as follows:

(2) Every State shall draw up regulations to prevent pollution of the seas from the dumping of radioactive wastes.

(3) All States shall co-operate in drawing up regulations with a view to preventing pollution of the seas or air space above, resulting from experiments or activities with radioactive materials or harmful agents.

The debate which took place on these paragraphs was far from moderate. Delegates of Afro-Asian, Latin and even Western European nations in NATO were adamant in their insistence that the Conference adopt regulations forbidding pollution of the high seas. They appeared not to appreciate the possible tempering effect of establishing a quantitative relationship in using the word pollution.

In one of the most tense sessions at the Conference, Committee II, by a vote of 30 for, 29 against, with 6 abstaining, adopted a United States-United Kingdom (U.S.-U.K.) resolution proposed as a substitute for the above paragraphs (2) and (3). This joint amendment reads as follows:

> The United Nations Conference on the Law of the Sea,
> Recognizing the need for international action in the field of disposal of radioactive wastes in the sea,
> Taking into account action which has been proposed by various national and international bodies and studies which have been published on the subject;
> Noting that the International Commission for Radiological Protection had made recommendations regarding the maximum permissible concentration of radioisotopes in the human body and maximum permissible concentration in air and water,
> Recommends that the IAEA, in consultation with existing groups and established organs having acknowledged competence in the field of radiological protection should pursue whatever studies and take whatever action is necessary to assist States in controlling the discharge or release of radioactive materials to the sea, promulgating standards, and in drawing up internationally acceptable regulations to prevent pollution of the sea by radioactive material in amounts which would adversely affect man and his marine resources.

There seemed to be resentment that the U.S.-U.K. resolution was an attempt to remove pollution of the high seas by radioactive materials from the jurisdiction of this Conference. This was not intended, but could so be construed.

It was obvious that with such a close vote the adopted resolution would probably be lost in the Plenary Session of the Conference. Reflecting further the determination of the delegates from many nations to include in the I.L.C.regulations one or more paragraphs dealing with the prevention of radioactive pollution of the seas, at the next meeting of Committee II, a joint proposal for a new Article following 49 was introduced by delegates from Argentina, Ceylon, India, and Mexico. Happily the U.S.-U.K. delegates, noting that there was ground for misinterpreting their intentions, offered to accept these new articles with some revision, provided the already approved amendments to Article 48 were not altered. Accordingly, the chairman appointed a sub-committee to resolve differences and to revise the proposed Four-Power article.

Although the delegates of the Four-Power nations were not familiar with the technological problems allied with disposal of radioactive wastes, they were firm in their stand that disposal of radioactive wastes at sea must be brought under a strict control; at the same time they were agreeable to the U.S.-U.K. resolution.

At the next session of the Committee, the following new article under Four-Power sponsorship was unanimously adopted, 70-0-0:

1. Every State shall take measures to prevent pollution of the seas from the dumping of radioactive waste, taking into account any standards and regulations which may be formulated by the competent international organizations.

2. All States shall co-operate with the competent international organizations in taking measures for the prevention of pollution of the seas or air space above, resulting from any activities with radioactive materials or other harmful agents.

In conclusion, it is obvious that a real task lies ahead of the IAEA under the terms of the U.S.-U.K. resolution on both Articles 27 and 48 even though the Conference on the Law of the Sea adjourned without international agreement. Since ocean disposal--certainly of high level radioactive wastes--could bring on international repercussions, one might question if large sums of money should be spent to study the oceans merely for disposal of such wastes. Research and development funds might better be allocated to evaluating problems of disposal of low level radioactive wastes at sea, safe ultimate methods of disposal of high level wastes on land or in the extraction from waste materials, long lived nuclides which are most significant as radioactive contaminants of man and his environment.

There was no discussion at the International Conference on the Law of the Sea of the problems which nuclear propelled vessels might introduce in relation to pollution of the sea. This is an area which needs special study for at subsequent conferences of this kind it seems sure to be discussed. As a matter of fact, at a United Nations International Labor Conference, which was held after the Conference on the Law of the Sea adjourned, resolutions were introduced referring to the use of atomic energy for propulsion of ships and calling for evaluation of possible hazards to workers in the shipping industry, looking to protection of them against risks in question.

Once radioactive materials are released to the seas, there is little likelihood of recovery. It is worth recalling that the oceans and seas occupy about two-thirds of the earth's surface. They constitute an environment about which information is relatively sparce compared with knowledge of man's land environment. The extent to which future generations will obtain food and other resources from the sea is unpredictable. We are familiar with damage and destruction of land assets by careless and uncontrolled exploitation. It would seem prudent to proceed with caution in releasing high level radioactive contaminants to the oceans.

The extent to which important national defense instrumentation at critical points may someday be sensitive to increases in background radiation induced by disposal of radioactive materials to the oceans or harbors and their approaches may be worthy of some consideration.

It is important that the atomic energy industry be represented by technical staff at all international conferences where matters of interest or concern to the industry are scheduled or liable to be discussed. Because of the rapidly changing

technology of the industry, position papers prepared for delegates to such conferences should be prepared with assistance and advice from nuclear technicians familiar with the atomic energy program, especially in channels of research and development.

Disposal of radioactive wastes to the oceans is a subject of great concern to all nations, and is a matter involving policy of high levels both within the atomic energy industry and in international relations.

Representative HOLIFIELD. Our next witness is Mr. D. W. Pritchard of the Chesapeake Bay Institute, the Johns Hopkins University.

STATEMENT OF D. W. PRITCHARD,[6] CHESAPEAKE BAY INSTITUTE, THE JOHNS HOPKINS UNIVERSITY

Mr. PRITCHARD. Mr. Chairman and members of the committee, I have a very brief statement, that will take me less than 5 minutes to dispose of.

You heard Mr. Gorman treat the results of the United Nations Conference on the Law of the Seas in April 1958. In addition to the two articles dealing with pollution of the seas, which were mentioned by Mr. Gorman, a resolution was introduced containing the following recommendation:

> The IAEA, in consultation with existing groups and established organs having acknowledged competence in the field of radiological protection should pursue whatever studies and take whatever action is necessary to assist States in controlling the discharge or release of radioactive materials to the sea, promulgating standards, and in drawing up internationally acceptable regulations to prevent pollution of the sea by radioactive material in amounts which would adversely affect man and his marine resources.

As a result of this resolution, the IAEA Board of Governors proposed and the General Conference approved that the Agency should initiate a study of problems connected with the disposal of radioactive wastes in the sea. The initial result of this action was the establishment of an expert panel on the disposal of radioactive wastes in the sea. This panel is composed of scientists from each of the following countries: Canada, Czechoslovakia, France, India, Japan, the Netherlands, Sweden, United Kingdom, and the United States. In addition, the chairman, Mr. Brynielsson, is from Sweden. The Food and Agriculture Organization (FAO), World Health Organization (WHO), and United Nations Educational, Scientific, and Cultural Organization (UNESCO), are represented by observers on the panel.

This panel held its first meeting in early December 1958. It was recognized by the panel members at the outset that, because of the variability in the pertinent phenomena controlling the physical dispersion and movement, the geochemical exchange and the biological reconcentration of radioisotopes in the sea, no general statement of safe disposal rates could be made. Each proposed disposal site must be specifically evaluated.

The expert panel is considering the problem of: (a) Package waste disposal; (b) disposal of low-activity liquid effluent from shore-based reactors and chemical processing plants; (c) wastes from nuclear-powered ships. Though present practice calls for the storage of high-level fission products from spent fuel elements on land, the possibility of technical and economic changes in the future which would make disposal in the deep sea attractive suggests that this problem may also be considered by the panel.

Representative HOLIFIELD. May I ask at this time if that panel is going to be an operating group as far as initiating and actually carrying out these studies, or are they going to be a study group which will take the information which is now being developed on the opera-

[6] See biographical sketch, p. 1271.

tional and exploratory level and more or less digest it to make recommendations? What is the real function of this panel?

Mr. PRITCHARD. The function of this panel is to take existing information and to prepare recommendations in the form of reports upon which can possibly be based international conventions for international treaty agreements.

Representative HOLIFIELD. This is more or less a study panel, then, of existing material or material which may be developed, and it is not necessarily a panel that would go out and initiate the actual programs of research and development?

Mr. PRITCHARD. That is right. It will make recommendations regarding areas in which it feels there is serious lack of information, and in which research is required.

The goals of the panel include the preparation of recommendations which might form the basis for an international agreement. International registry of disposal sites, and the monitoring of such sites, are among the subjects being discussed. A major contribution of this panel will very likely be a clear-cut, step-by-step presentation of the procedures which should be followed in evaluating the suitability of any particular marine locale as a receiver of nuclear wastes. Here "suitable" implies negligible risk to man and to the products harvested from the sea by man.

The panel has established working parties which in cooperation with IAEA staff are evaluating specific areas of concern and will prepare drafts of specific portions of the final report for consideration by the full panel. Further meetings of the panel are planned for the spring of 1959, and it is hoped that the task undertaken by the panel can be completed during this calendar year. Included in the considerations of the various working parties are the needs for additional research work.

The International Atomic Energy Agency is also considering ways in which it can aid lesser developed countries in the development of adequate technical competence in the field of radioactive waste disposal. It is also considering methods by which the international exchange of scientific and technical information pertinent to the problems of waste disposal in the sea can be facilitated.

That concludes my testimony, Mr. Chairman.

Representative HOLIFIELD. Thank you, Mr. Pritchard.

Are there questions?

We will hear from Mr. Lauriston S. Taylor, Chief, Atomic and Radiation Physics Division, National Bureau of Standards, as our next witness.

Mr. Taylor, we are glad to have you before us again.

STATEMENT OF LAURISTON S. TAYLOR,[7] CHIEF, ATOMIC AND RADIATION PHYSICS DIVISION, NATIONAL BUREAU OF STANDARDS, AND MEMBER, INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION

Mr. TAYLOR. With your concurrence, Mr. Holifield, I would like to cut out some parts of my prepared statement and add one short remark at the end. I think I can still stay within my time limitation.

Representative HOLIFIELD. You may proceed in your own way.

Mr. TAYLOR. In the testimony to follow, I will deal only briefly with the background and total program of the International Commission on Radiological Protection and will devote most of the discussion to the waste disposal aspect of their program.

The International Commission, or ICRP, was formed in 1928, and has been in continuous operation ever since that time. This Commission has been responsible on an international level for setting the standards of permissible dose and working procedures for the safe use of radiation. Its work on an international level closely parallels that in this country of the National Committee on Radiation Protection and Measurements. In fact, the committee structure is very similar and there is a substantial overlapping of membership between the two bodies.

At the present time, with its subcommittees, its membership includes some 75 specialists in the radiation protection field drawn from about 15 countries. And I should remark that these people are chosen for their technical competence and not as national representatives of the country.

The Commission is independent of all direct governmental ties, but does have close working relationships with intergovernmental groups, as for example the World Health Organization.

At the present time, in addition to the main Commission, the ICRP has five major subcommittees, of which I will mention three.

Subcommittee 1, on permissible dose for external radiation, has Dr. G. Failla, from this country, as its chairman; subcommittee 2, on the permissible dose for internal radiation, has Dr. Karl Morgan, from this country, as chairman; and subcommittee 5, on the handling of radioactive isotopes and the disposal of radioactive wastes, has Dr. C. B. Straub, of this country, as chairman.

So, of the five committees, three are chaired by people from this country. I might remark, incidentally, that Dr. Failla and Dr. Morgan have for some years been chairmen of the corresponding committees of the NCRP.

A report of the Commission dealing with all of the subjects that I have mentioned above is now in the course of preparation for pub-

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[7] Chief, Atomic and Radiation Physics Division, National Bureau of Standards.
Education: Stevens Institute of Technology and Cornell University, 1920–27.
Background: X-ray section, National Bureau of Standards, 1927–40, Chief, X-ray section, 1940–49; Chief, Radiation Physics Laboratory, NBS, 1949–53; U.S.A.F. 1943–45; Chief, Biophysics Branch, U.S. Atomic Energy Commission, 1947–48; Chief, Atomic and Radiation Physics Division, 1951–present.
Committees: Chairman, National Committee on Radiation Protection and Measurements, 1929 to present; member, International Commission on Radiological Protection, 1929 to present; member, International Commission on Radiological Units and Measurements, 1928 to present; Chairman, ICRU, 1953 to present; member, National Academy of Sciences Advisory Committee on Civil Defense, 1953 to present; Chairman of NAS Advisory Committee on Civil Defense, 1957 to present; numerous other related committees and interdepartmental advisory committees.

lication and should be ready for release—at least in part—within the next 4 to 6 weeks, I believe.

From this point on, I will deal briefly with the portion of the ICRP program dealing with waste disposal.

Sources of radioactive wastes have been classified into three groups. The first would include the relatively small laboratories using for the most part short-lived radioactive isotopes. Information for the control of this type of situation is pretty much in hand.

The second group would include larger laboratories or industrial operations using long-lived isotopes, and, in general, requiring disposal by somewhat special means.

The third group would include large-scale operations, such as those in the AEC or its major contractors, the producers of nuclear power, and so on.

It is in this last category that the most severe waste disposal problems are arising.

In addition, the problem of handling and disposal of radioactive isotopes will depend upon the quantities and the nature of the isotope involved. In this connection, the United States, United Kingdom, and Canada divide the overall hazard into four principal categories.

France, as an example, uses only three categories, so that there is a possibility of some degree of inconsistency here, which may influence the actual formulation of an international program.

The new report of the ICRP will include sections dealing with area monitoring and decontamination. This covers not only monitoring within plants, but outside monitoring of the environment, where there may either be spills or planned release or disposal of radioactive wastes.

In this area, there is still considerable work that needs to be done with regard to instrumentation and procedures. In this country, instrumentation and procedures are reasonably well standardized, but the U.S. practices will undoubtedly differ substantially from those of some other countries.

An endeavor is being made to bring about a better degree of order and understanding of this problem on an international basis, so that intergovernmental arguments will not arise over small differences in technical detail.

Another problem relative to the exposure of the population, while not strictly one of waste disposal, has to do with the problems of storage and transportation. At the present time, there is a study underway reviewing the existing national and international regulations in these areas to insure that the recommended levels of radioactivity conform with those that have been adopted by the International Commission.

Determination is needed as to whether or not to consider, for example, airline pilots, truckdrivers, freight handlers, as radiation workers. If not, it is possible that they may be considered as overexposed at times, and an increase in the amount of shielding in transportation will be required. And this will, of course, importantly influence our waste disposal problem.

It has been agreed that this group will be considered as in the general population class, but that many statements relative to them will have to be reworded so as to make their radiation status clear.

In connection with the discussion of radiation levels during transportation, it is important to realize that measurement techniques and instrument calibrations would depend upon the recommended radiation units.

The committee will consider problems that may arise from the operation of nuclear-powered ships, but the recommendations will be confined to rather broad general terms of a basic nature, with the detailed requirements left to other established international groups more directly concerned. It is felt that the committee should be responsible for insuring that the basic recommendations of the other groups conform to those of the ICRP.

The initial report on this subject will of necessity deal somewhat superficially with the problem of waste disposal from reactor operations. While this is potentially one of the largest of waste disposal contributions, the initial report will not go much beyond indicating the sources of waste and what is being done about them. Detailed recommendations will take a considerable time to develop.

The preliminary report of the ICRP will deal only briefly with the problem of waste disposal in the ocean. At the present time, the main source of guidance in this area is handbook 58 of the National Committee on Radiation Protection, entitled, "Radioactive Waste Disposal in the Ocean." This was prepared in 1954 and will undoubtedly be superseded by the much more complete study of this problem which is now underway by a special committee of the National Academy of Sciences.

At the present time, there is no universal public health system for measuring radioactive pollution, and the ICRP urges that public health agencies recognize their responsibilities in this area of public health and develop programs for radioactive monitoring, assay, and control. By this means they will be able to note changes in the level of the activity in the environment in order to institute control measures before any harmful increases may occur in these levels.

It is expected that the World Health Organization, with whom the ICRP has an official working relationship, will take some degree of leadership on an international basis in this field.

The ICRP has not yet attempted to establish specific levels for permissible radioactive contamination, as such. However, it has already clearly enunciated the proposal that waste disposal level should be such that no individual is likely to receive radiation exposure in excess of $\frac{1}{10}$ of that allowed for controlled radiation workers. Since within any population group it is unlikely that the entire group would be so exposed, it would appear that this specification would be adequate to suitably hold down the overall population exposure level. It is recognized that this situation may not remain valid indefinitely, but it certainly appears to be adequate for the foreseeable future.

The ICRP has studied the problem of exposure of large population groups to radiation from sources other than natural. For protection against deleterious genetic effects it has suggested that for large population groups the permissible exposure be set at $\frac{1}{100}$ the levels for occupational exposure. It has recognized the impracticability of setting firm levels for somatic damage as, for example, leukemia and bone sarcoma. Such levels as may be set for somatic effects will have

to be based upon our evaluation of the overall national risk in terms of the overall national gain.

The Commission has also discussed rather briefly the problem of apportioning the dose to be received from various radiation sources that may be within man's control, and states very clearly that such apportionment, if decided upon, must be made by national authorities.

It should be pointed out that these questions have been examined critically by the National Committee on Radiation Protection in this country and while the committee does not necessarily disagree with the ICRP it prefers, at this time, not to concur in the recommendations. Continuing with our present conservative procedures we believe that there is no serious risk in leaving this question open a while longer while the committee actively examines it. In the meantime, a special subcommittee of the NCRP has the question under intensive study. Without wanting to anticipate their conclusions it seems fairly evident that they will not want to set the population exposure primarily on the basis of a factor of one-hundredth applied across the board to the occupational levels for all radionuclides. It is believed that the acceptable levels may differ substantially for different radionuclides depending upon their particular characteristics and the particular biological damage against which protection is sought. If this proves to be the case, it may be possible to set different acceptable exposure levels for different radionuclides in such a way as to provide liberal protection and at the same time not hamper the adequate use of radionuclides in the service of man.

That, sir, concludes my statement.

I would like to ask that the supporting documents that were listed in my letter of January 27 to Mr. Ramey be considered for possible inclusion in the record.

Representative HOLIFIELD. They will be so considered.

Dr. Rodger, you have a question, I believe.

Dr. RODGER. There is, of course, always the give and take between those like yourselves, Dr. Taylor, who set protection limits, and many people who are operators, who wish to see things more liberal, so that they may operate, and there has been a cycling back and forth on this throughout the history of our industry. I remember one time when the official attitude of the AEC was, "Thou shalt not let one atom that thou hast produced get away from thee."

I guess everyone became quite used to working with the limits that were initially set by your committee, a very monumental piece of work, and I think some of the operators were perhaps taken a bit aback at the 10-percent number that was put out, I think as a result of the three-power conference some years ago. I think they were even more taken aback by this 1/100 number that has come up in these hearings a number of times; another evidence of this pushing toward tighter restrictions is the discussion brought out by Dr. Revelle and Pritchard of sea-level contamination, which is based, I would think, on a series of superimposed worst possible situations.

I wonder if you would comment on this continual battle that we may always expect in light of a statement of Mr. Klassen's paper which I liked very much, which has something to do with the commonsense attitude to these problems of waste disposal "in order to

prevent this vital atomic energy industry from reaching the brink of being economically purified out of business."

Mr. TAYLOR. Well, I could not agree more with that statement, myself. I am frankly very much concerned at times for fear that with the public pressure that is being exerted in this field at the present time we may be setting levels lower than ultimate wisdom will prove to have been correct.

There is a very real danger, if one keeps going down and down, that we will price ourselves out of the adequate use of this new and very valuable tool. And at some time—and I am sure we do not know how we are going to do it—we are going to be faced with the problem of balancing the risk that may come along with the use of radiation against the advantages that it offers us.

You cannot compare, for example, radiation risk with automobile driving risk. We know that automobile driving is a very risky business; but these two things are not comparable. And yet they are part of the daily hazards of life.

The present trend is to be extremely conservative, in the light of our present knowledge.

Take the genetic problem. The evidence has indicated that there may be substantial potential hazard to future generations. We can guess, but that is all we can do, that the future generations may adapt themselves to an increased radioactive environment. We do not know this. Until we do know something about it, we really have to play safe.

I suspect that the levels that we have set now are for the most part fairly manageable. In fact, in setting the levels as low as they are, we have been guided to some extent by the experience of large users of radioactive materials who have themselves been more conservative than called for by the national or international groups, and found that they could still operate.

There is one point about this that worries me. If we find out in the future, as we might, that some of these situations are not as hazardous as they appear today, we may have difficulty in adjusting our permissible levels up again.

On the other hand, circumstances may force us to do this if we find ourselves, for example, being strangled a few hundred years from now for lack of power.

Does that answer your question?

Dr. RODGER. More or less, yes. There is one other aspect of this that we have discussed in these hearings, the desirability of the control of policing measures, moving downward to the traditional areas of the States. One of the problems has been that in using the levels which you initially set up, say, in the order of the 10 to the -7th power microcuries per milliliter range, this takes a certain degree of technique. They are not impossible to handle, but they are somewhat difficult. And part of the problem has been that you have to develop and train a group of people in a flock of different places who can work at these places. Going down by a factor of 10 makes it difficult, and going down by a factor of 100 makes it very difficult to distinguish what you are doing from actual background.

I am disturbed by the superimposition factors of 10 upon a situation which I think you were extremely conservative on in the first place. You already have a large safety factor in the 10 to the −7th power microcuries per milliliter. You assume they are the worst, and oftentimes they are not essentially the worst.

Mr. TAYLOR. It is for such reasons as you have indicated that the national committee in this country has preferred not to subscribe outright to this particular philosophy that has been suggested by the ICRP.

I wish that we could avoid some of the public pressure on this problem, because, as I have stated many times in many ways, if we continue our present practices, which experience has shown are reasonably conservative, we are not likely to do our population any very serious damage by going on for a few more years. During this period we may improve our knowledge, and then make the decisions.

Dr. RODGER. I heartily applaud your efforts to resist.

Chairman DURHAM. That is the reason we sit here hour after hour, Doctor, and try to get as much information out to the public as we possibly can.

I notice you refer to the hearings that we held before on this radiation hazard. I express my desire and hope that the public will read this as well as that document, because I understand now it is being used quite extensively in the colleges throughout the country.

Mr. TAYLOR. The trouble is that things are not very newsworthy when they are safe.

Chairman DURHAM. But it is our effort, as you stated, to explain to the public that we are operating under safe procedures at the present time.

Representative HOLIFIELD. Thank you very much for your testimony, Dr. Taylor.

(Dr. Taylor's formal statement follows:)

WORK OF INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION

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In the testimony to follow, I will deal only briefly with the background and total program of the International Commission on Radiological Protection and will devote most of the discussion to the waste disposal aspect of their program.

But first I would like to comment on the reporting of these proceedings. The two volumes covering the Fallout Hearings two years ago are better known in some circles as the "Green Bible". They make an invaluable collection of information on fallout problems. I hope that these hearings will be documented similarly.

The ICRP was formed in 1928 and has been in continuous operation ever since that time. This commission has been responsible on an international level for setting the standards of permissible dose and working procedures for the safe use of radiation. Its work on an international level closely parallels that in this country of the National Committee on Radiation Protection and Measurements. In fact the subcommittee structure is very similar and there is a substantial over-lapping of membership between the two bodies.

The ICRP as originally established consisted of 6 or 7 members, of which I was one. At the present time with its subcommittees its

membership includes some 75 specialists in the radiation protection field drawn from about 15 countries. The Commission is independent of all direct governmental ties but does have working relationships with inter-governmental groups, as, for example, the World Health Organization.

(For the record I would like to submit a brief account of the work of the ICRP since its original formation in 1928. I also submit a membership list.)

At the present time, in addition to the Main Commission, the ICRP has five major Subcommittees; Subcommittee 1 on Permissible Dose for External Radiation, with C. Failla from this country as Chairman; Subcommittee 2 on the Permissible Dose for Internal Radiation with K. Z. Morgan from this country as Chairman; Subcommittee 3 on Protection Against X-Rays Generated at Potentials Up to 3 Million Volts with R. G. Jaeger of Germany as Chairman; Subcommittee 4 on X-Rays above 3 Million Volts, Beta-Rays, Gamma-rays and Heavy Particles, including Neutrons and Protons, with H. E. Johns from Canada as Chairman; Subcommittee 5 on the Handling of Radioactive Isotopes and the Disposal of Radioactive Wastes with C. S. Straub of this country as Chairman.

I might remark that Failla and Morgan have for some years been Chairmen of the corresponding Subcommittees of the National Committee on Radiation Protection and Measurements in this country.

The last full meeting of the ICRP was held over a two-week period in New York City in March of this year and it is anticipated that a report from the Commission dealing with all of the subjects mentioned above will be ready for release early this year.

From this point on I will deal briefly with the portion of the program of the ICRP dealing with waste disposal.

Sources of radioactive wastes have been classified into three groups. The first would include the relatively small laboratories using, for the most part, short-lived radioactive isotopes. Information for the control of this kind of situation is pretty much in hand. The second group would include larger laboratories or industrial operations using long-lived isotopes and, in general, requiring disposal by somewhat special means. The third group would include large-scale operations such as those in the AEC or its major contractors, the production of nuclear power, etc. It is in this last category that the most severe waste disposal problems will arise.

In addition the problem of handling the disposal of radioisotopes will depend upon the quantities and the nature of the isotope involved. In this connection the United States, United Kingdom and Canada divide the overall hazard into four categories. At the present time France uses only three categories so that there is a small range of inconsistency here. An example of the classification

of the problems is illustrated on the accompanying page. I will not attempt to discuss this in any detail at the present time, other than to point out that it is essential on an international basis that there be agreement in this basic classification, which defines the overall problem.

The new report of the ICRP will include sections dealing with area monitoring and decontamination; this covers not only monitoring within plants but the outside monitoring of the environment where there may either be spills or planned release or disposal of radioactive wastes. In this area there is still considerable work that needs to be done with regard to instrumentation and procedures. In this country instrumentation and procedures are reasonably well standardized but the United States practices will differ substantially from those of some other countries. An endeavor is being made to bring about a better degree of order and understanding of this problem on an international basis so that intergovernmental arguments will not arise over technical details. For example the recommendations on waste disposal recently put out by IAEA are based on ICRP recommendations.

Another problem relative to the exposure of the population, while not strictly one of waste disposal, has to do with problems of storage and transportation. At the present time there is a study underway reviewing the existing national and international regulations in these areas to insure that the recommended levels of radioactivity conform with those adopted by the ICRP.

Determination is needed as to whether or not to consider air-line pilots, truck drivers, freight handlers, etc. as radiation workers. If not, it is possible that they may be considered as overexposed at times and an increase in the amount of shielding in transport will be required. It has been agreed that this group will be considered, as in the general population class, but that many statements relative to them be reworded, so as to make their radiation status clear. In connection with the discussion of radiation levels during transport it is important to realize that measurement techniques and instrument calibrations would depend upon the recommended radiation units. Measurements in roentgens cannot be made for beta-radiations but can be used for gamma-rays. The rad will be the unit used in the measurement of contamination. The committee will consider problems that may arise from the operation of nuclear powered ships but the recommendations will be confined to general terms, with the detailed requirements left to other established international groups. It is felt that the committee should be responsible for insuring that basic recommendations of the other groups conform with those of the ICRP.

The initial report will of necessity deal somewhat superficially with the problem of waste disposal from reactor operations. While

this is potentially one of the largest of the waste disposal contributions the initial report will not go much beyond indicating the sources of waste and what is being done about them. Detailed recommendations will take some considerable time to develop.

The preliminary report of the ICRP will deal only briefly with the problem of waste disposal in the ocean. At the present time the main source of guidance in this area is Handbook 58 of the National Committee on Radiation Protection and Measurements entitled "Radioactive Waste Disposal in the Ocean." This was prepared in 1954 and will undoubtedly be superceded by the much more complete study of this problem now underway by the National Academy of Sciences.

At the present time as there is no universal public health system for measuring radioactive pollution, ICRP urges that public health agencies recognize their responsibilities in this area of public health and develop programs for radioactive monitoring and assay. By this means they will be able to note changes in the level of the activity in the environment in order to institute control measures before any harmful increase in these levels occur . It is expected that the World Health Organization, with whom the ICRP has an official working relationship, will take some degree of leadership on an international basis in this field.

The ICRP has not yet attempted to establish specific levels for permissible radioactive contamination. However, it has already clearly enunciated the proposal that waste disposal levels should be such that no individual is likely to receive radiation exposure in excess of one-tenth of that allowed for controlled radiation workers. Since within any population group it is unlikely that an entire group would be so exposed, it would appear that this specification would be adequate to suitably hold down the overall population exposure level. It is recognized that this situation may not remain valid indefinitely but it certainly appears to be adequate for the foreseeable future.

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The ICRP has studied the problem of exposure of large population groups to radiation from sources other than natural. For protection against deleterious genetic effects it has suggested that for large population groups the permissible exposure be set at 1/100 the levels for occupational exposure. It has recognised the impracticability of setting firm levels for somatic damage as, for example, leukemia and bone sarcoma. Such levels as may be set for somatic effects will have to be based upon our evaluation of the overall national risk in terms of the overall national gain.

The Commission has also discussed rather briefly the problem of apportioning the dose to be received from various radiation sources that may be within man's control, and states very clearly that such apportionment, if decided upon, must be made by national authorities.

It should be pointed out that these questions have been examined critically by the National Committee on Radiation Protection in this country and while the Committee does not necessarily disagree with the ICRP it prefers at this time not to concur in the recommendations. Continuing with our present conservative procedures we believe that there is no serious risk in leaving this question open a while longer while the Committee actively examines it. In the meantime, a special subcommittee of the NCRP has the question under intensive study. Without wanting to anticipate their conclusions it seems fairly evident that they will not want to set the population exposure primarily on the basis of 1/100 factor applied across the board to the occupational levels for all radionuclides. It is believed that the acceptable levels may differ substantially for different radionuclides depending upon their particular characteristics and the particular biological damage

against which protection is sought, If this proves to be the case, it may be possible to set different acceptable exposure levels for different radionuclides in such a way as to provide liberal protection and at the same time not hamper the adequate use of radionuclides in the service of man.

F. REPORT OF COMMITTEE V ON THE HANDLING OF RADIOACTIVE ISOTOPES AND THE DISPOSAL OF RADIOACTIVE WASTE

I. INTRODUCTION

The object of this report is to recommend precautions which may be necessary in the handling and disposal of radioactive materials to maintain radiation levels below the maximum permissible levels recommended by Committees I and II. This report cannot give detailed recommendations, necessary and sufficient for all cases. The national groups using these recommendations must assume the responsibility for the proper selection and maintenance of the standards necessary for safe operation under their specific conditions.

Several aspects dealing with the handling and disposal of radioactive materials are considered in this report, namely:

(i) the laboratory facilities to be provided;

(ii) the procedures to be adopted in handling, storing, and transporting radioactive materials; and

(iii) the procedures to be adopted in the safe disposal of radioactive wastes.

In the use of radioactive materials two problems arise for which effective control must be provided. First, there is the health hazard to the radiation worker from external sources and internally deposited radioactive materials, and to the people beyond the radiation (control) area due to the transport and release of radioactive materials. Second, there is the contamination hazard in the radiation area which may adversely affect the results of the scientific work in progress.

The precautions recommended here to avoid such health hazards and interference with scientific work are based on general safety principles, and upon the external and internal radiation limits recommended by the International Commission on Radiological Protection. These principles include:

(i) careful design of working places and equipment;

(ii) proper working methods;

(iii) area monitoring for radiation as a check on (i) and (ii); and

(iv) personnel monitoring for external and internal exposure as a check on the whole system.

The application of these principles becomes more important with larger amounts of radioactive material, but should be applied even in dealing with low levels of radioactivity, since good working habits are essential. Bad example and careless working habits may expose associates and contaminate facilities outside the immediate radiation (control) area.

The mishandling of sources of radiation has led to injury in the past. Unfortunately, as radiation injury, in most cases, takes a long time to develop, it is often difficult for workers to appreciate the need for the various recommended precautions and to maintain the required vigilance. Those working with radioactive substances must be aware of the nature of radiation hazards and thoroughly versed in the methods of keeping their radiation exposure as low as possible. They, and their employers, must appreciate the consequences of an indifferent attitude toward over-exposure, and every effort should be made to work at minimal radiation levels. The general practice should be to work as far below the maximum permissible levels as possible.

Any organization in which radioactive materials are used should designate a competent person or persons (Isotope Committee) whose duty it is to examine the program of work in relation to the radiation hazards involved, and to be responsible for drawing up local rules. One or more technically competent individuals (radiation safety officers) should be designated as specifically responsible for implementing radiological protection measures in the department. The radiation safety officer should acquaint every worker, in the area where radioactive materials are used, with the local rules. He should see that the worker reads, understands, and follows these rules.

In the past, radiation protection basically has involved protection of the worker and maintenance of a safe working environment. Thus, the emphasis has been on the individual as an occupational worker, and the agencies having a responsibility in occupational health and a safe working environment could exercise the necessary degree of control over the industrial application and use of radioactive materials. With an expanding program, the probability of exposing larger segments of the population to radioactive materials increases. The responsibility for control in this area is not as well defined. This responsibility will vary, according to whether the materials are in transit or whether they are discharged into the atmosphere, ground, sewerage system, or water course. This Committee urges, therefore, that in each country the general level of radiation, irrespective of source, be kept under surveillance to permit evaluation of the over-all radiation picture and to co-ordinate precautionary measures.

II. FACILITIES NECESSARY FOR LABORATORY WORK WITH OPEN SOURCES OF RADIOACTIVE MATERIAL

There are several factors that are common to all operations with radioactive materials. Some of these will be indicated here; others in the sections that follow. One of the cardinal principles in the use of radioactive materials is that the laboratory be segregated, insofar as possible, from other operations, much in the same way that bacteriological laboratories dealing with pathogenic organisms or chemical and other laboratories handling toxic agents are segregated from other activities. Furthermore, only authorized persons should have access to such laboratories.

1. Classification of Isotopes

Unsealed isotopes present both an external and an internal hazard. Places where they are used must provide for handling, storage, and disposal. The complexity of the facilities required for handling radioisotopes depends on the amounts and toxicities of the materials used and the operations involved.

The values given in Table C. VIII of the Report of Sub-Committee II (1), for the maximum permissible amount of radioisotope in total body and maximum permissible concentration in air and water for continuous exposure, are a rough guide to the relative harmfulness of the isotopes when deposited in the body. In practice, the degree of hazard associated with the manipulation of unsealed radioisotopes will depend upon additional factors, such as the chemical form of the radioisotope, specific

activity, volatility, relative radiation dose to critical organs and tissues when accidental ingestion or inhalation occurs, radioisotope laboratory facilities, and complexity of the procedures involved. Taking into account the above factors, a broad classification of isotopes into four categories is suggested according to their degree of hazard, and this is set out in Table F. I.

2. Facilities Required for Radioisotope Laboratories

The type of laboratory required depends on a variety of factors, including, particularly, the nature of the operations being conducted and the quantities and toxicities of the isotopes involved. Therefore, three grades of laboratory (designated Types 1, 2, and 3) have been defined. Table F. II., indicates, for certain levels of radioactivity, the grade of laboratory which experience shows to be desirable for various types of work. In Type 2 laboratories, which employ intermediate levels of radioactivity, no clear cut division (as indicated by the slant boundries in Table F. II) can be made as much depends upon the exact nature of the work.

Brief descriptions are given below of the three types of laboratories.

Type 1 Laboratory (Low level facility). The Type 1 laboratory is suitable for all tracer work and for simple operations with millicurie quantities of the less hazardous isotopes. Any modern conventional chemical laboratory having floors covered with linoleum or other suitable material may be used with few modifications. Work benches should be

Table F. I. Classification of isotopes according to relative radio-toxicity

Class A (Very high toxicity): $Sr^{90} + Y^{90}$, Po^{210}, At^{211}, Ra^{226}, Ac^{227}, Pu^{239}, Am^{241}, Cm^{242}.

Suggested isotopes to be added:

Ra^{228}, Th^{228}, Th^{230}, Th^{232}, Np^{237}, Pu^{238}, Pu^{240}, Pu^{242}, Am^{243}, Cm^{243}, Cm^{244}, Cm^{245}, Cm^{246}, Cf^{249}, Cf^{250}, Cf^{252}.

Class B (High toxicity): Ca^{45}, Fe^{59}, Sr^{89}, Y^{91}, $Ru^{106}+Rh^{106}$, I^{131}, $Ba^{140}+La^{140}$, $Ce^{144}+Pr^{144}$, Sm^{151}, Eu^{154}, Pb^{210} + drs, $Th^{234}+Pa^{234}$, U^{233}.

Suggested isotopes to be added:

Ca^{47}, I^{126}, I^{129}, Nd^{144}, Sm^{147}, Eu^{152} (13y), Eu^{155}, Hg^{203}, Pb^{212}, Bi^{206}, Bi^{207}, Bi^{210}, Bi^{212}, Ra^{223}, Ra^{224}, Ac^{228}, Th^{227}, Pa^{230}, U^{230}, U^{234}, U^{235}, U^{236}, U^{238}, Pu^{241}, Bk^{249}.

Class C (Moderate toxicity): Na^{22}, Na^{24}, P^{32}, S^{35}, Cl^{36}, K^{42}, Sc^{46}, Sc^{47}, Sc^{48}, V^{48}, Mn^{52}, Mn^{54}, Mn^{56}, Fe^{55}, Co^{58}, Co^{60}, Ni^{59}, Cu^{64}, Zn^{65}, Ga^{72}, As^{74}, As^{76}, Br^{82}, Rb^{86}, $Zr^{95}+Nb^{95}$, Nb^{95}, Mo^{99}, Tc^{96}, Rh^{105}, $Pd^{103}+Rh^{103}$, Ag^{105}, Ag^{111}, $Cd^{109}+Ag^{109}$, Sn^{113}, Te^{127}, Te^{129}, I^{132}, $Cs^{137}+Ba^{137}$, La^{140}, Pr^{143}, Pm^{147}, Ho^{166}, Tm^{170} (Changed from B to C), Lu^{177}, Ta^{182}, W^{181}, Re^{183}, Ir^{190}, Ir^{192}, Pt^{191}, Pt^{193}, Au^{196}, Au^{198}, Au^{199}, Tl^{200}, Tl^{202}, Tl^{204}, Pb^{203}.

Suggested isotopes to be added:

A^{31}, Co^{57}, Co^{58m}, Ni^{63}, Ni^{65}, Zn^{69m}, Zn^{69}, As^{73}, As^{77}, Se^{75}, Kr^{85m}, Kr^{85}, Kr^{87}, Rb^{87}, $Sr^{91}+Y^{91}$, $Sr^{92}+Y^{92}$, Y^{90}, Y^{92}, Y^{93}, Zr^{93}, Nb^{93m}, Tc^{97m}, Tc^{97}, Tc^{99}, Ru^{97}, Ru^{103}, Ru^{105}, $Pd^{109}+Ag^{109m}$, Ag^{110m}, Cd^{115m}, Cd^{115}, In^{114m}, In^{115}, Sn^{125}, Sb^{122}, Sb^{124}, Sb^{125},

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Table F. I. (Cont.)

Te^{125m}, Te^{127m}, Te^{129m}, Te^{131m}, I^{133}, I^{134}, I^{135}, Xe^{133}, Xe^{135}, Cs^{134}, Cs^{135}, Cs^{136}, Ba^{131}, Ce^{141}, Ce^{143}, Pr^{142}, Nd^{147}, Pm^{149}, Sm^{153}, Eu^{152} (9 h), Gd^{153}, Tb^{160}, Dy^{166}, Er^{169}, Tm^{171}, Yb^{175}, Hf^{181}, W^{185}, Re^{186}, Re^{187}, Re^{188}, Os^{185}, Os^{191}, Os^{193}, Ir^{194}, Pt^{193m}, Pt^{197}, Hg^{197m}, Hg^{197}, Rn^{220}, Th^{231}, Pa^{233}, Np^{239}.

Class D (Slight toxicity): H^3, Be^7, C^{14}, F^{18}, Cr^{51}, Ge^{71}, Tl^{201}.

Suggested isotopes to be added:

Si^{31}, Cl^{38}, A^{37}, Zr^{97}-Nb^{97}, Nb^{97}, Tc^{96m}, Tc^{99m}, Rh^{103m}, In^{113m}, In^{115m}, Cs^{131}, Cs^{134m}, Nd^{149}, Gd^{159}, Dy^{165}, Er^{171}, Os^{191m}, Pt^{197m}.

The chemical form of the isotope may in some cases greatly affect its toxicity.

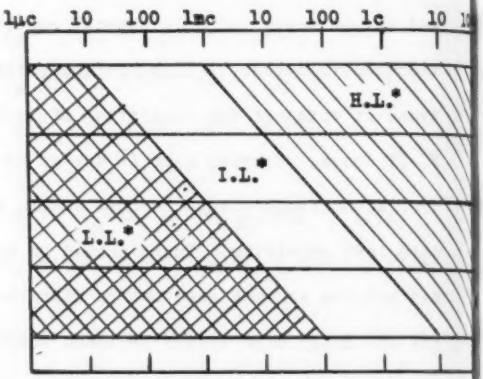
provided with non-absorbent tops and disposable covers. There should be a conventional fume hood with fan,* and the exhaust air should be carried outside the building, but need not be filtered.

Type 2 Laboratory (Intermediate level facility). The Type 2 laboratory is suitable for most operations with millicurie quantities of activity and may be described as a typical hospital isotope laboratory handling therapeutic doses. A high grade chemical laboratory is suitable for the types of work and the quantities of isotopes of the order shown in Table F. II above. Greater care in design is necessary to facilitate the control of contamination. Benches should be of sufficient strength to accommodate lead shielding. There should be at least one good fume hood with fan but the exhaust need not be filtered. If air conditioning is used in the building, care should be taken that the air flow into the fume hoods is adequate to prevent recirculation of contaminated air. In addition to fume hoods, it may be necessary to use glove boxes, which considerably reduce the hazards from inhalation or ingestion of radioactive materials. It should be appreciated, however, that in some circumstances the gain made from using glove boxes is offset partly by increased exposure to external radiation resulting from longer handling time, and partly by the tendency for workers to exercise less care in maintaining cleanliness.

A detailed description of this type of laboratory is given in Appendix F. A.

* Even though the fume hood is not necessary for reasons of radioactivity, it may be useful purely for chemical reasons.

Table F II.

Relative Toxicity of Isotope	Toxicity Classification of Isotopes	Grade of Laboratory Required for Isotope at Levels of Activity Specified Below
Very High	A	
High	B	
Moderate	C	
Slight	D	

* L.L. - Low level - Type 1
I.L. - Intermediate level - Type 2
H.L. - High level - Type 3

The activity levels specified above are intended as a general guide and not as rigid regulations. They will be subject to modification according to the skill and experience of the operators and the type of work being done. Suggested modifying factors are given below.

Modifying factors to be applied to the above quantities, according to the complexity of the procedures to be followed.

Procedure	Modifying Factor
Very simple wet operations (e.g., preparation of aliquots of stock solutions)	x 10
Normal chemical operations (e.g., analytical procedures, simple chemical separations)	x 1
Complex wet operations (e.g., multiple chemical operations or operations involving complex glass apparatus)	x 0.1
Simple dry operations (e.g., preparation of aliquots or mixing of powders)	x 0.1
Dry and dustry operations (e.g., grinding)	x 0.01

In the average hospital laboratory for the therapeutic and diagnostic application of isotopes, space may have to be provided for:

(i) receipt and handling of radioisotopes;

(ii) storage of radioactive solutions;

(iii) assay of isotopes prior to administration to patients, and measurement of excreta and specimens for radioactivity; and

(iv) measurement of the up-take and distribution of the isotopes in patients.

If the types and quantities of isotopes dealt with are more hazardous, it will be necessary usually to have separate rooms in which to carry out the above procedures.

Type 3 Laboratory (High level facility). For the higher levels of activity, a specially designed laboratory will be required; this usually will be necessary only for isotope production and atomic energy purposes, and possibly in the larger isotope therapy centers. Access to the laboratory should be made through a special change room, and full-scale health physics coverage of the work is essential.

If air conditioning is required, the unit should be separate from any other system in the building. It is most important to install a filter system near the junction of the fume hood and exhaust stack, and also to the outflow from glove boxes. The filters should be so situated that they can be monitored and changed easily without escape and dispersal of accumulated contamination.

III. FACILITIES AND PROCEDURES NECESSARY FOR WORK WITH DISTRIBUTABLE SOURCES

By "distributable sources" is meant those sources that are commonly moved from place to place. They are chiefly used in industrial radiography, medical therapy, and for calibration purposes.

Sealed sources present potential hazards of external exposure from beta and gamma radiation, and of internal exposure resulting from inhalation and ingestion of radioactive material that may escape from the source. Precautions must be taken to guard against both external and internal hazards. The use of sealed sources should be under the supervision of someone who is qualified to institute the appropriate precautions.

1. External Radiation Exposure

When the source is in use or in storage, steps must be taken to ensure that overexposure of people cannot take place. Sufficient shielding and working distance must be provided for this reason. Warning signs and barriers may have to be erected to prevent unauthorized entry into significant radiation fields.

a. Facilities

People who handle these sources should always do so with remote handling equipment. Such sources should never be picked up with the fingers. Handling equipment should be easy and convenient to use; cumbersome, overlong, and heavy tools should be avoided, since the

longer time required to manipulate them may result in needless exposure. The sources themselves should be so designed that they can be quickly and easily cleaned.

b. Procedures

In certain types of work, particularly in the making up of medical applicators and in some industrial radiographic procedures high doses can be received by experienced operators, even when practicable shielding and long handled tools are used. It may be necessary to adopt a rotating system of duties to keep personnel exposures below maximum permissible levels.

All persons who handle sources, or who may have a radiation exposure potential of more than 1/10 of the maximum permissible dose, should wear personnel monitoring devices, such as film badges or pocket ionization chambers. It should not be forgotten that in handling sources the dose to fingers and hands may be much more significant than the whole body dose, so that films and ionization chambers should, if practicable, be worn on the fingers as well as on the body. If these cannot be worn during specific operations, practice runs should be made allowing measurement of the actual exposures to the fingers and hands.

A radiation survey should be made regularly to determine the adequacy of facilities, equipment, and safety procedures. This survey should include all storage containers and shields, and space occupied by any personnel who work in the radiation area. The survey should also include the examination of all shielded sources for leakage. The results of these surveys should be maintained as a matter of record.

2. Internal Radiation Exposure

The possibility of ingesting or inhaling radioactive material arises if a sealed source starts to leak. It is important, therefore, that sealed sources should be constructed in such a way that the likelihood of leakage is minimized, and that they are used in such a way that the escape of radioactive materials is rendered unlikely. For this reason, care should be taken to prevent bending, dropping, and heating of sources. At the same time, even when these precautions have been taken, all sealed sources should be tested for leakage at regular intervals. A leaking source may cause contamination, which is both hazardous and costly to remove.

To test a radioactive source for leakage, the source should be placed close to or wrapped in absorbent material such as cotton or filter paper, and left for at least a day, preferably in a small sealed container. The absorbent material should then be checked for contamination with an ordinary portable alpha, beta, or gamma survey instrument. Gross contamination can be detected by merely wiping the source and testing the wipe for

contamination, or by dipping the source in non-corrosive liquid, evaporating the liquid, and counting the sample.

A leaking source should be placed in a sealed container, but heat sealing -- as in a glass tube or by soldering a metal container -- should be avoided. Arrangements should then be made with the manufacturer or some qualified laboratory to receive the source for repair. Care should be taken during transportation of the leaking source to prevent contamination of the package. (For emergency procedures following a major leakage, see Appendix F.B.).

Beta sealed sources should be permanently sealed. For short-lived beta sources prepared in the laboratory, the rules defined for handling sealed sources apply. Leakage of beta sources should be checked by means of wipe tests or by repeated calibrations at regular intervals and comparison with other available standards.

IV. WORKING HABITS AND PROCEDURES

1. General Precautions

The recognition of three factors -- shielding, distance, and limitation of exposure time -- as the allies of the radiation worker is the key to good working habits.

In working with unsealed sources, the additional necessity for control must be considered. The worker with radioactive nuclides resembles the bacteriologist in the sense that he must protect himself, his fellow workers, and the environment from the spread of contamination. This object is achieved by the application of certain general principles:

(i) Particular thought must be given to the reason for various procedures.

(ii) Protective clothing, including rubber gloves, must be worn in the laboratory and removed before leaving.

(iii) Techniques should be selected which cause a minimum of dust and spray and which avoid unnecessary handling of radioactive material.

(iv) The laboratory structure, equipment, and furniture must be covered to protect them against spills of radioactive material.

(v) Persons and objects leaving the laboratory must be monitored to ensure that contamination is not being taken out of the room.

Good working procedures are so important that techniques must be well thought out and understood before work is undertaken. New procedures should be tried out by practice runs so that when active material is used, operations are performed speedily and confidently with minimum exposure and risk of accident. The procedure should be approved by the officer-in charge (radiation safety officer). Hurried manipulations cause accidents

and only by careful planning and knowledge of permissible levels and working distances can the factor of "time" be reconciled with safe operation.

No pipetting or glass blowing by mouth can be permitted in a radiochemical laboratory. Vessels containing radioactive material must be covered when not in use.

Working surfaces in the laboratory should be covered with absorbent paper and manipulations carried out over trays made of non-absorbing material (e.g., stainless steel, enameled metal, polythene) lined with absorbent material (e.g., paper). All work involving spray, fumes, or gas evolution must be done in a fume hood.

Spills will occur, and it is the responsibility of the person who causes the spill to notify the proper persons who will see to it that it is effectively cleaned up (see Spills, page 17). If the amount of radioactive material used is no greater than that needed to carry out the given operation, the seriousness of spills and also of exposure to personnel in normal work will be reduced.

A waste can containing a strong non-absorbent or somewhat waterproofed paper liner would be placed in a position convenient to each worker. The can will normally be used for slightly contaminated material and must be monitored and changed with sufficient frequency to ensure that it does not become a hazard.

Eating and smoking should not be permitted and cosmetics and articles for their application should not be admitted in areas where radioactive materials are being used or handled. Personal habits such as sucking pencils and fingers must be recognized as being likely to contribute to internal contamination.

The unbroken skin is an effective barrier against direct entry of isotopes into the blood stream, so precautions must be taken to avoid cuts and puncture wounds. If there are open wounds on exposed parts of the body, whether bandaged or not, no work should be permitted with the more hazardous materials or larger quantities of the less hazardous ones. Cracked and chipped vessels must not be used in radiochemical laboratories.

Persons who have handled radioactive materials should on leaving the laboratory wash their hands thoroughly with soap and water, first with the gloves on and again after removal of the gloves. Particular attention should be paid to the finger nails, which should be kept short. After washing, the hands should be checked by a radiation monitoring instrument. If contamination remains after two washings, special decontamination procedures as determined by a physician may be required (see VI. 2. a).

The cleaning of floors, benches, and furniture should be done by a wet or moist method and dry sweeping should be avoided. Housekeeping personnel should be instructed in the proper techniques of cleaning (see Appendix F. A. 2. d.)

2. Spills

a. Minor spills

A spill is treated as a minor spill if the amount of nuclide involved falls within the range of quantities used to define Type 1 laboratories (Table F. II.). In the case of a minor spill, there is little radiation hazard to personnel.

Absorbent paper should be laid immediately over a wet spill. Wet absorbent paper should be laid over the affected area in case of a dry spill. The paper should then be removed to a suitable waste receptacle and the affected area monitored. Decontamination should be carried out until the surface is free of removable radioactivity. Swabbing should always be done inwards towards the center of the spill and the immediate locality of the spill should be decontaminated before attention is given to slight contamination of surrounding areas. If contamination levels cannot be reduced, the surface must be stripped or covered (see Area Monitoring and Decontamination, V. 2.). In all of these operations great care should be taken to avoid spread of the radioactivity and to prevent contamination of clothing and hands.

b. Major spills

Major spills involve amounts of nuclides greater than those given for Type 1 laboratories in Table F.II. Such a spill must be regarded as an emergency, but appropriate action will vary according to circumstances. Local regulations for dealing with major spills, therefore, must be drawn up and posted in the laboratories. An example of such regulations,

appropriate for a large laboratory handling toxic materials, is given in Appendix F. B.

3. Additional Precautions in Medical Work

The additional precautions needed in medical work differ widely according to the amounts, decay schemes, and half lives of the isotopes used, as well as to their routes of administration and excretion. It is undesirable, therefore, to propose general rules, but essential that both nursing and laboratory staff should be aware of any special sources of hazard associated with the treatments with which they are dealing. In particular, the following points may require care, and appropriate radiation measurements should be made in developing methods of procedure to establish that no hazards exist.

(i) Radium sources used for medical purposes should not be sterilized by over heating, since this may cause the containers to rupture (2). In the case of cesium sources, however, heat sterilization may be used.

(ii) In certain types of work, particularly in the making up of medical applicators, high doses can be received by experienced staff, even when practicable shielding and handling tools are used. It may be necessary to adopt a rotational system of duties to keep personnel exposures below maximum permissible levels.

(iii) Appropriate measures should be taken to avoid undue local irradiation of the operator's hands, which may occur during parenteral administration of large doses or during implantation of sealed sources, including radium.

(iv) Radioactive material in patients may be sufficient to give significant exposures to nursing and other staff. The degree of hazard should be assessed by appropriate monitoring. Exposures of staff can be minimized by placing the beds of such patients at a distance from the nursing station.

(v) The nursing and other staff should know which excreta become radioactive after each type of treatment, and should be instructed concerning safe disposal procedures. They should know which excreta (including accidental vomits) must be preserved, and which can be rejected.

(vi) Bed linen may become contaminated as a result of incontinence or of leakage of radioactive material from wound. The handling and disposal, including laundering, of bed linen should be under the supervision of the radiation safety officer.

(vii) Dressings from patients receiving treatment involving interstitial, intracavitary or surface applications with sealed sources should not be destroyed until all appliances have been removed and the dressings monitored.

(viii) Precautions should be taken to ensure that cadavers containing radioisotopes cannot be hazardous to pathologists, undertakers or others. The radiation safety officer should supervise any autopsy or embalming procedure involving a cadaver which contains a therapeutic amount of a radioisotope.

4. Radioactive Luminous Compounds

Although strictly not a laboratory operation, requirements for dealing with radioactive luminous compounds or paints are included herein because these materials are dangerous if not handled properly.

The basic objective in the design and operation of such facilities is to avoid the inhalation of these compounds or paints, to prevent the ingestion of these materials by direct transfer to the mouth, and to minimize external exposure. To attain this objective, the preparation and application of radioactive luminous compounds or paints should be carried out under suitable, ventilated exhaust hoods with the current of air away from the worker toward the work, the exhaust air being discharged in such a manner that re-entry into the building is prevented.

In addition to a suitably ventilated hood, each operator should be provided with the following facilities:

(i) A chair of smooth, washable finish.

(ii) A rack for painting tools.

(iii) A lidded non-tipping crucible or container with a capacity of approximately 1 gram of prepared radioactive luminizing material.

(iv) A closable metal waste basket with disposable liner.

(v) Tissue handkerchiefs in a dispenser.

(vi) Thin rubber gloves.

(vii) A protective gown or smock without pockets. A hook or hanger should be provided in the work-room for this garment.

The relevant provisions specified under Design of Working Places, Working Habits and Procedures, Area Monitoring and Decontamination, Personnel Monitoring and Decontamination, and Storage of Radioactive Isotopes apply with equal force to this particular activity.

V. AREA MONITORING AND DECONTAMINATION

1. Area Monitoring

The radiation safety officer should carry out periodic monitoring as a check on the safety rules laid down and to confirm that they are being observed.

(i) The radiation levels should be measured at various points, particularly near where radioisotopes are stored, where shielded walls have been erected, or near waste pipes and containers. In the interest of keeping exposures at a minimum, it is suggested that radiation levels due to contamination in the laboratory be kept as low as practicable, preferably below one mr/hr. Values in use are summarized in Appendix F. C.

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(ii) Because of contact with contamination from benches, equipment, protective clothing, etc., a worker may receive higher doses than the survey indicated in (i) would suggest. Wiping tests should be made to measure loose contamination. If detected, such contamination should be cleaned up. For suggested levels of activity see Appendix F. C.

(iii) The radiation officer should satisfy himself that the concentrations of isotopes in the working atmosphere are below maximum permissible levels (Reports of Committees I and II).

(iv) Maintenance work, e.g., on laboratory equipment or waste pipes, should be undertaken only after preliminary monitoring. If unexposed parts are opened up during the work, monitoring should be undertaken as the work progresses.

2. Decontamination

The object of decontamination is to reduce contamination to a point where it is no longer significant in terms of the two criteria pointed out in the Introduction, namely; that the health hazard to the radiation worker from radioactive materials be kept to a minimum, and that the contamination level not adversely affect the results of the scientific work in progress.

Because of the wide variety of contaminants and surfaces, little more than general principles can be given; indeed it is undesirable that more should be attempted since each decontamination procedure must be worked out as an individual problem. Rules of thumb cannot be set up wisely. Owing to the high toxicity of many alpha-emitting isotopes--when inhaled or ingested--and the meticulous care necessary for their detection, removal of loose alpha contamination is particularly important.

Many proprietary wetting and sequestering agents are used as aids in decontamination, and since these may vary from nation to nation, the Committee does not feel that these should be indicated. Furthermore, sufficient literature is available describing the various techniques that have been used and found satisfactory (3, 4, 7 - 14).

(i) Walls, floors, and benches

Decontamination should be attempted first by scrubbing with soap, water, and detergent until a wiping test or monitoring instruments show the absence of radioactivity. To minimize contamination of surfaces and to facilitate decontamination, it is wise to cover benches with material such as waterproofed paper or polythene sheeting, and floors with linoleum or other approved covering.

Concrete floors should always be covered with an impervious removable floor covering, such as linoleum, to minimize penetration of contamination and for easy mopping up of spills. Concrete is particularly prone to wear and presents an inhalation hazard; in consequence, it is difficult to specify safe levels of contamination. In general, short-lived contamination of a half-life less than a month may be covered without surface removal after scrubbing to remove loose contamination. But substantial long-lived contamination remaining after scrubbing may necessitate covering or removal of surface, since either it will be there for a long time or it will escape. Where temporary covering is adopted, regular monitoring to check whether the contamination is escaping should be made.

(ii) Glassware and equipment

The utmost care is necessary (for scientific and not health reasons) to prevent contamination in work involving measurement of low levels of radioactivity. Such work should always be completely segregated to prevent the possible contamination of utensils, glassware, or reagents, and that none of these have been used in work involving high levels of activity.

Metal tools should be monitored. They may often be cleaned by washing with detergent, followed, if necessary, by acid or complexing agents. If they cannot be satisfactorily decontaminated, they should be discarded as waste material and handled accordingly.

(iii) Clothing

Any article of protective clothing or personal clothing which is found contaminated, should be placed in a container provided for the purpose.

Contaminated clothing should not be released to public laundries unless the activity is below the suggested levels indicated in Appendix F. C. For articles contaminated above these levels with short-lived isotopes, storage is recommended until the activity has fallen below the indicated levels. Care should be taken to prevent air-borne contamination from handling of such clothing.

Where special laundering facilities are available, as for example, in a hospital or an atomic energy establishment, special techniques, recommended by the radiation safety officer should be used, and the decontaminated articles should be checked by him before reuse. Where such facilities are not available, and where storage of garments is not practicable, the garments would have to be considered as radioactive waste materials and disposed of accordingly.

VI. PERSONNEL MONITORING AND DECONTAMINATION

1. Personnel Monitoring

a. External radiation

The amount of external radiation received should be systematically checked to ensure that the doses for the various types of radiation and parts of the body involved do not exceed those recommended by Committees I and III. Workers using millicurie quantities of radioactive materials should be required to wear proper film badges at all times, irrespective of whether they wear pocket ionization chambers. Direct use of open beta sources in this activity range may result in significant beta radiation of the hands. The degree of exposure in such instances should be controlled by careful planning of the experimental procedures and checked by wearing wrist or finger films which are sensitive to beta rays.

b. Internal radiation

Tests may have to be carried out from time to time upon workers who use unsealed radioactive nuclides in order to estimate the contribution to the body burden of one or more radionuclides (see report of Committee II). Certain workers in

Type 3 laboratories will need such tests, but those in Type 1 laboratories will rarely require them. Iodine workers in Type 2 laboratories should be subject to such tests on a routine basis as indicated below.

At present the assessment of body burden of radioactive material is usually attempted by measurement of the radioactivity of the excreta, particularly of the urine. For this purpose, sample collecting techniques defined by the examining laboratory must be strictly followed. If the examination is called for as the result of a particular incident, the nature and time of the incident must be accurately recorded.

For workers using I^{131}, the uptake of the nuclide in the body may easily be estimated by external neck counts taken at two-week intervals.

In the case of workers with radium, the total body burden is usually estimated from the measurement of radon in the exhaled breath. In a limited number of places, specialized equipment is available to estimate the total body burden of gamma-emitting isotopes or of amounts of beta-emitters large enough to give rise to measurable amounts of Brehmsstrahlung.

2. Personnel Decontamination

a. Contamination of hands

Hands are normally decontaminated as in IV. Working Habits and Procedures. If contamination is present after two washings, the hands may be scrubbed with soap or detergent and water. If two scrubbings are ineffective in removing the contamination, the case should be referred to a physician informed about radiation problems. It is most important to realize that the skin is an excellent barrier to absorption of radioactive material provided that its surface remains intact, so harsh cleaning methods must be avoided. Moderate activity which remains fixed to the skin after the application of the above procedures is unlikely to be dangerous to anyone, whereas employment of harsher measures might injure the skin and expose the subject to internal contamination. In case of contamination with plutonium, the physician may find it necessary to excise the skin.

Spots of very high persistent contamination of the skin by dangerous long-lived isotopes could be covered by means of adhesive material to be removed only on occasion of subsequent periodical washing.

b. Contamination of other portions of the body

Care should be taken to prevent the spreading of contamination to other parts of the body. If corrosive materials are not involved, the gross contamination should be mopped with absorbent tissue. Following this, the area should be gently washed with soap and water. Great care should be taken, during decontamination of the face, that contaminated liquid does not fall on to the lips or into the eyes. If the eye is being irrigated for contamination, it should be ascertained that the adjacent skin is not highly contaminated; measures should be taken first to prevent such contamination from being irrigated into the eye. One should irrigate the eye outwards to avoid contamination of tear ducts.

If contamination is still present after such procedures, a physician with knowledge of radiation problems should be consulted.

3. Contamination of Wounds

If the skin is accidentally broken when working with radioactive materials, the wound should be irrigated immediately with tap water, the edges of the gash being spread to assist the flushing action of the water, and to encourage bleeding. All wounds of this nature should be referred to a physician with experience in handling radiation problems as soon as the first aid measures have been started, so that steps can be taken to free the wounds from contamination.

4. Radioactivity Deposited in the Body

A person who is suspected of inhaling or ingesting appreciable quantities of radioactive material should be referred immediately to a physician experienced in radiation problems. Vomiting should be induced immediately after the ingestion of appreciable quantities of radioactive materials. An emetic or other procedure may be used to induce such vomiting or, in the interest of saving time, one can use his finger to induce such vomiting. Specialized techniques are required for determining the actual amount of radioactivity in the body, and also for attempting to remove the material.

VII. STORAGE OF RADIOACTIVE ISOTOPES

Where uranium enriched in the uranium 235 isotope, uranium 233 or plutonium is handled and stored, the quantities involved and the storage plan must be approved by a specialist in criticality problems, who must be informed of all relevant circumstances such as the possibility of the admission of water into storage areas. Other radioactive materials, when not used, should be stored in an area assigned for the purpose. The removal of material from this area should be controlled by a responsible person (radiation safety officer). All areas where radioactive materials are stored should be properly marked with approved warning signs.

Consideration should also be given to 1) shielding, 2) contamination, and 3) fire and theft.

1. Shielding

Radioactive materials may emit combinations of alpha, beta, and gamma radiation, and neutrons. Alpha emitting sources should be stored in a closed container, but require no special shielding. Shielding should be provided for gamma emitting isotopes to protect not only those who enter the room, but those who work in adjacent areas. (Information on shielding against gamma emitting sources is given in the report of Committee III). Pure beta emitting isotopes should be stored in individual containers having walls that will absorb the beta radiation completely. Substances of lower atomic number should be used for beta shielding. Usually 4 to 5 mm of glass, 7 to 8 mm of plastic, 15 to 20 mm of wood will suffice. Paraffin or other hydrogenous materials are convenient for neutron shielding. Radium-beryllium sources of neutrons containing up to 100 millicuries of radium do not require shielding in addition to the lead required for gamma shielding. Above 100 millicuries, additional shielding -- hydrogenous or other material -- may be required.

2. Contamination Control

Unsealed isotopes should always be stored in tightly closed vessels. If the vessel is liable to breakage, it should be kept in an outer unbreakable container. Gaseous radioactive materials, or preparations that can give off radioactive gases, should be stored in a fume hood. Before these materials are removed from the fume hood, the fan should be operated for a period of time necessary to remove the radioactive gases.

3. Fire and Theft

Buildings where radioactive materials are stored should be as nearly fire-proof as possible. Local fire departments should be informed of any buildings or areas where major hazards may be encountered, and also of the degree of the hazard involved. If possible, hazardous quantitites of radioactive materials should be stored in non-destructible, fire-proof safes. The radiation safety officer or an authorized deputy should be readily available on a 24-hour basis, so that in the event of a fire, he can arrive quickly to assess the radiation hazard to the fire fighters. Storage areas should be so located that flooding is not possible.

Radioactive sources should be stored under lock and key. Any loss or theft of radioactive material that may constitute a potential health hazard should be reported to police and public health authorities, so that immediate steps can be taken for its recovery.

VIII. TRANSPORTATION OF RADIOACTIVE MATERIALS

1. General Principles

a. Within the establishment

The radiation safety officer should be responsible for the movement of appreciable quantities of radioactive materials from one laboratory to another within an establishment. He should indicate the amounts of shielding required to minimize the exposures received by personnel handling the material.

b. Outside the establishment by public transport

The operative principle here is to ensure that no worker or member of the public receives more than the maximum permissible dose as specified by Committee I and II for the general population. Where the weekly dose level exceeds 1/10 of the maximum permissible occupational level, the workers must be classed as radiation workers and subjected to the same safeguards as are occupational radiation workers, namely: proper medical examinations and radiation monitoring. Where the dose will not exceed 1/10 of the occupational permissible level, no action is necessary, and the persons in question are treated as members of the general public.

This whole subject requires considerable study and resolution, particularly from the standpoint of types of containers to be used, vehicles of transport, routes to be followed to provide for emergency handling of spilled material resulting from wrecks, etc.

c. Outside the establishment by private transport

It will be necessary, as nuclear power is developed to transport very large amounts of radioactive materials, mainly irradiated fuel. Although, to a certain extent, the general principles discussed in the last section apply, it becomes

desirable also to provide against the effects of an accident which, by spreading the material by spillage or as a smoke in case of fire, could cause serious local contamination. The authority responsible for the transport should have trained employees who could move as a squad, if necessary, and rapidly decontaminate an area. A radiation safety officer of the authority responsible for the shipment should accompany the radioactive material, but preferably not in the vehicle carrying the shipment.

The shipping authority should ensure that the crew of the vehicle carrying radioactive material not receive more than the maximum permissible exposure recommended by Committee I, and that the crew is equipped with suitable devices for reading the exposure.

2. Specific Items

Because of the somewhat confused state of knowledge relating to the transport of radioactive materials and the wide variety of materials to be transported, ranging from the mined ore to the finished fuel on the one hand, and from radioisotopes, spent fuel, and fission products waste on the other, no specific principles have been set out in the Committe's report.

This subject is under study and eventually the Committee hopes to provide detailed recommendations in regard to container design and construction, packing, weight, marking and labeling. Furthermore, information will have to be given relating to the various types of vehicles used, safety precautions in regard to each, permissible exposures to crews and passengers, the problem of routing, and the notification of health or other interested agencies of the movement of these materials so that necessary emergency action could be mobilized if needed.

Pending further study, present international regulations should be followed.

IX. DISPOSAL OF RADIOACTIVE WASTES

1. General Principles

Radioactive wastes, whether in gaseous, liquid, or solid form, are pollutants. They should be released to the environment only under conditions which ensure that they are reduced quickly to an innocuous level. The problem of radioactive waste handling or disposal involves knowledge of the following: 1) the quantities and kinds of materials released, 2) the behavior of the individual radioisotopes between the point of release and entrance into the human body, and 3) the behavior of individual radioisotopes in the human body. Problems of the first class are those presented to the waste disposal organization by the departments which originate the wastes and can be greatly simplified or

complicated by the nature of the processes which give rise to the wastes. Problems of the second class involve such considerations as dilution of the radioisotopes after release into the environment, possible seepage of the radioactive materials into the water table or subterranean streams if ground disposal is practiced, and concentration of the chemical elements -- both stable and radioactive -- by metabolic processes of plants and animals or physical and chemical processes in minerals. To adequately define the potential hazard resulting from such release, it is obvious that the talents of many individuals will be required to evaluate the complex factors involved. Problems of the third class include the effects of the various radiations on body tissues, as well as consideration of the body uptake, distribution, and excretion. These have been considered in the report of Committee II.

The final criterion of the success of any radioactive waste disposal system is the absence in harmful quantities of such materials in the air, water, and food. Since at present there is no public health system for measuring such pollution, the Committee urges that public health agencies recognize their responsibilities in this area of public health, develop a program of radioactive monitoring and assay to note changes in the level of activity in the environment, and institute control measures before any harmful increase in these levels occur. The public health agencies should be informed of the quantities and kinds of radioactive materials shipped into and used in the area under their jurisdiction, and should be consulted

with reference to the amounts and kinds of waste materials released into the environment.

Since the waste materials may be either gaseous, liquid, or solid, there can be no single solution to the problem. The solution will vary also with the specific operations under consideration; for example, radioisotope laboratories, hospital treatment centers, or atomic energy installations. Two general techniques, however, may be considered to apply in all cases. These are dilution and dispersion or confinement and control. Examples of each of these techniques under specific conditions will be given subsequently.

A cardinal principle in dealing with any wastes containing radioactive materials, is that if treatment for the removal of the pollutant is contemplated, such treatment should be carried out as near the point of production of the waste as possible. Dilution of the wastes will usually make them more difficult to treat.

2. Disposal Techniques

a. Dilution and dispersion

Dilution and dispersion presents the most convenient method of waste disposal and has found extensive use. Dilution may take two forms, i.e., dilution with stable isotopes of the same element in the same chemical form or dilution with media other than stable isotopes of the same element.

As a general principle, dilution with a stable isotope of the same element is most appropriate for the more common chemical elements found in nature, as, for example, phosphorus, calcium, sulfur, carbon, etc. Obviously, isotopic dilution would not be considered where such use might result in a chemical toxicity problem. Dilution with other media, in general, involves dispersal of gaseous materials in the atmosphere or of liquids in sewerage systems and streams. The possibility of reconcentration of the activity in surrounding media by chemical or physical means or by biological systems must be taken into consideration, particularly in the latter case. When dilution or dispersal is employed, control of the radioactive material is sacrificed.

One special case of dilution medium is the use of concrete, the active materials being contained in the liquid used to mix the concrete. The mixture is placed in steel drums and finally disposed of by storage or burial on land or at sea. Burial may be justified on the assumption that the concrete may be eroded only at a slow rate, but it must be remembered that concrete is a permeable material which will be leached by water. This factor can be reduced by enclosing the drums in a concrete monolith.

b. Containment and control

Containment and control is exercised when the waste materials are stored, with or without previous concentration or other treatment, in suitable facilities which prevent release of the waste materials into the environment. The purpose of such confinement is to permit the waste materials to decay to a lower level of activity which will permit further processing or release without exceeding permissible levels. In the case of short-lived radioactive materials such storage is desirable, except that it is rather costly. Where long-lived materials are handled such storage facilities should be provided.

Containment is often preceded by concentration. Here the waste is reduced to smallest practicable bulk for storage in suitable facilities. The method of concentration may include evaporation, chemical precipitation, solvent extraction, ion exchange, fixation on soil, etc. In the case of combustible solid wastes, concentration in incinerators of proper design may be practicable. In some instances, baling of combustible wastes has been used in lieu of incineration and to reduce spatial requirements for above ground storage or burial.

3. Disposal of Wastes

a. Type 1 laboratories

(1) Airborne wastes. If an incinerator is used to burn combustible materials containing radioactivity, some airborne activity may be released into the environment, but such activity will not be dangerous.

(2) Liquid wastes

(i) Sewer discharge. In any radiochemical laboratory there will always be some radioactive liquid wastes, if nothing more than wastes from washing contaminated laboratory glassware. Normally, these wastes may be discharged to the drains without precaution but occasionally small volumes of higher activity need to be wasted, e.g., remains of stock solutions. It is desirable, therefore, that each institution should have a specified weekly limit, reached after consultation with the public health authority. Such limits would be based on the levels recommended by Committee II if the waste ultimately reaches a stream used as a source of drinking water. In other cases, a limit of 10^{-4} μc/ml on the effluent from the institution normally would be sufficient, although often higher

levels could be allowed without hazard to the public. The rate of discharge of the higher level wastes half-life less than 2 weeks should be adjusted so that the momentary concentration in the public sewer does not exceed 0.1 uc/ml. It is recommended that sewage authorities be notified of the proposed waste discharges.

(ii) Storage and disposal. Where higher concentrations of the radioactive wastes are to be disposed of, these may be stored until decay permits disposal by dilution or they may be collected by a public or commercial radioactive waste collector (where such services exist) for disposal in an approved manner.

(3) Solid wastes. Solid wastes include contaminated laboratory glassware and equipment, contaminated paper, floor covering, etc. Combustible materials may be disposed of by incineration. The ash, together with other non-combustible material, may be buried in approved areas. It is impossible to lay down precise specifications for burial areas since they involve so many locally determined factors such as rate of movement of ground water, type of soil, proximity of public water supplies, and the particular isotopes in use. The site selected must be such as to avoid contamination of water supplies and crops and must be approved by a public health or other agency having jurisdiction.

b. Type 2 laboratories

(1) General. Among these laboratories will be included certain industrial and academic research institutions as well as most hospital laboratories. According to Table F. II, the amount of very highly toxic nuclides handled in normal chemical operations will be 10 μc to 10 mc, but if only simple wet operations are carried out 100 mc of such material could be present. It is apparent, therefore, that stricter control must be exercised in disposal of wastes from these laboratories than in the case of wastes from Type 1 laboratories. This is particularly clear when it is realized that such wastes would include the clean-up material from major spills.

Industrial and academic research laboratories are more likely to use significant amounts of long-lived isotopes than hospitals, so their disposal problems are correspondingly more difficult. There are no methods of disposal for this type of waste sufficiently well established to be recommended by the Commission, although a considerable literature exists in which various disposal schemes are discussed. It is suggested, therefore, that, if storage is impractical and it is impossible to attain acceptable dilution for disposal, the wastes should be returned to the supplier of the radioactive material.

(2) Hospital laboratories. Hospital wastes fall into three groups, classified according to the character of the isotopes employed: unsealed radioisotopes with half-lives not greater than 2 weeks, employed in research, diagnostic and therapeutic procedures; unsealed isotopes of intermediate half-lives, up to several months, employed mainly in research and always in small quantities; and, isotopes in sealed sources, used chiefly for external radiation.

For hospital wastes in general, disposal by either sewer or by incineration will be the method of choice. The former will be the route for all liquid wastes and the latter for combustible materials.

(i) Gaseous wastes. Radioactive gases will be released during the incineration of experimental animals, and contaminated articles containing radioactive materials. Calculations and/or measurements should be made to determine the level of activity discharging from the stack or present in the ash.

(ii) Liquid wastes. These may arise from several sources: (a) excreta (urine, feces, and sputum), (b) accidents (spills, vomits, cadavers), (c) unused stock solutions, and (d) laundry wastes.

(a) Excreta. The urine from patients treated with radioisotopes may contain the bulk of the radioactivity administered, and the rate of elimination may be quite rapid, as in the case of iodine. The hospital physicist will know roughly the amount excreted and may allow it to be discharged without assay. When this is not so, or when the amount excreted exceeds the permitted weekly discharge (reached after consultation with the public health authorities), the material should be collected and assayed, and, if necessary, stored until decayed sufficiently to permit discharge.

It is of some importance, in order to safeguard workers in the sewers and at the disposal works, that momentary high concentrations in the sewage should not occur. In order to achieve this, slow discharge from a constant drip device may be desirable. It has been suggested that 0.1 uc/ml at the outfall of the institution should be the maximum level for all isotopes of half-life less than two weeks.

Although these levels are not considered hazardous at the moment, since discharge is not

continuous, it is recommended that levels (general population) approaching those recommended by Committee II be used in calculating the amounts of radioactive material that may be discharged. Furthermore, in cases where the sewage from a hospital is discharged into water which subsequently forms a part of a public drinking water supply, the activity discharged, together with other discharges of radioactivity into the same water, ultimately should not produce the maximum permissible concentration in downstream populations. (See Ref. (1), Section C. X. 9). The permissible average concentration in a hospital sewage will vary, therefore, very widely according to its situation with regard to water supplies and the maximum level could be determined only after consultation with water and sewage authorities who could provide information about river flows and other discharges.

It will not be worthwhile or necessary usually for regular measurement of radiation levels at sewage works, but as a check on the

concentration of radioactive materials by biological slimes and sludges, the works manager should arrange occasional surveys, say, once every two or three months. No doubt those responsible for the discharge normally would do this for him in the interests of good relations, but the facilities of the national atomic energy and public health agencies would also be available.

The discharge of long-lived radioactive materials should be evaluated in terms of the environmental factors. (See discussion under Type 3 laboratories).

(b) Accidents. Spills (see page 17 and Appendix F. B.). Vomits, if collected in containers, may be flushed down sink drains in a manner described above for Excreta.

Where body fluids are removed from cadavers containing radioactive materials, these may be disposed of as indicated under Excreta.

(c) Unused stock solutions. Depending on the nature and amount of radioactive material present, the disposal techniques indicated under Excreta may be applied.

(d) Laundry wastes. It is not expected that the concentration of radioactive materials present in hospital laundry wastes will be appreciable and these wastes may be discharged directly into the sewer after monitoring. Contaminated linen would not normally be sent to the laundry, but might be stored to permit decay of the short-lived activity before laundring.

(iii) Solid wastes. Combustible wastes from hospitals including laboratory animals, contaminated materials, etc., may be incinerated and the radioactive ash collected and disposed of by a suitable method (burial where permitted or removed by a waste collector). Stack effluents should be monitored to determine that no hazard exists.

c. Type 3 laboratories

This type of laboratory is usually associated with an Atomic Energy Authority which has an established waste disposal system. The quantities of waste discharged will greatly exceed those from Type 1 and 2 laboratories and special precautions must be exercised to avoid hazardous contamination of the environment. The wastes should pass through a continuously monitored delay tank sufficiently large to deal with an unexpected discharge of highly active material and arrangements should be available to divert such waste to a holding tank for special treatment. All material passing out of a Type 3 laboratory will be monitored. In this connection, it must be remembered that a disposal

which has an external radiation field which is not dangerous to those handling the disposal may contain material (e.g., alpha and soft beta emitters) which would be extremely hazardous when released into the environment.

(1) Reactor operations. A wide variety of radioactive wastes will result from reactor operations. These may be gases, airbourne particulates, liquids, and solids, and will depend upon the design of the reactor -- whether air, gas, liquid or solid (sodium) cooled; whether of the single pass or recirculating coolant variety; whether fueled with heterogeneous or homogeneous type fuels; whether single or two region type, etc. In the sections which follow some of the more important sources of the various kinds of wastes have been described.

(i) Airborne wastes. Air used for cooling the reactor is filtered to remove particulate matter before passage through the reactor to reduce the amount of induced activity formed. On passage through the reactor, some induced activity will be formed, particularly argon, and the cooling air may pick up corrosion products and fission products from fuel element repture or from improperly cleaned fuel elements. The air is generally passed through a bank of filters before release into the atmosphere and, with the exception of short-lived argon, contains little activity.

In one instance (the Calder Hall reactors), the reactors are cooled by recirculating carbon dioxide gas, a portion of which is filtered and reintroduced into the system after passing through the reactor.

(ii) Cooling water. Natural water or heavy water may be used for cooling purposes.

If natural water is used, treatment generally consists of coagulation or softening to reduce levels of such materials as iron, calcium, etc. This water is not recirculated, but is discharged after passage through the reactor. Tanks are provided to permit decay of the short-lived radioisotopes formed, as for example, sodium 24. When the activity reaches permissible levels of discharge, it is released into the environment. Downstream monitoring to observe biological concentration is desirable, since it provides a good tool for controlling discharge of radioactivity.

In newer reactor types, deionized water is used for cooling. It is recirculated after passing through demineralizers to remove the induced activity, corrosion products, and fission products. Deionized make up water is added as needed. Heavy water is always recirculated and ion exchange columns are provided to remove

radioactive contamination. The ion exchange resins are handled as solid wastes and disposed of as such.

(iii) Solid wastes. There will be solid wastes produced during reactor operations which will have to be disposed of. These include spent resins already referred to and filters from the air cleaning operations. Incineration may be used to reduce the bulk of these wastes prior to packaging for burial on land or disposal in the sea.

(2) Laboratory operations. The wastes discharged are as varied as the laboratory operations themselves, and include discharges from tracer laboratories, pilot plant areas, area decontamination wastes, etc. Accordingly, the levels of activity will cover an extremely wide range. Airborne, liquid, and solid wastes will result from these operations.

(i) Airborne waste. Any operation involving airborne waste should be carried out in properly ventilated exhaust hoods discharging to the outside air. Whether the air passes through filters prior to discharge is a function of the levels of activity involved.

(ii) Liquid wastes. Treatment and/or disposal methods may be selected depending on the level of activity encountered. In many cases involving tracer quantities

of radioactive materials (microcurie to millicurie levels), simple retention in settling basins plus dilution with water will reduce the levels of activity to the limits recommended by Committee II. Where large volumes of low activity waste are discharged, periodic monitoring should be carried out in the stream with assay of the flora, fauna, and bottom muds.

If the wastes are of an intermediate level (millicurie to curie levels), they should be pretreated before discharge into the receiving stream, ground, or ocean. Pretreatment may include evaporation, carrier precipitation, ion exchange, biological uptake, crystallization, solvent extraction, electrodialysis, differential volatility, or some other process. Considerable literature is available on the results obtainable by the use of these methods. It must be remembered that the concentrated activity fraction must still be handled in such a way as to avoid hazard. The usual method of handling includes storage in tanks or dewatering before burial on land or in the oceans in packaged form.

Disposal into the ground is practicable where there is no danger of contaminating ground water sources and where geological and hydrological conditions are favorable. In the use of this method, control of radioactivity is sacrificed. Extensive and expensive monitoring wells are required to determine the rate of movement of the liquid front as well as the movement of specific radioactive and stable ions through the soil. Obviously, if there is any possibility of contact between these wastes and ground or surface waters used as a source of water supply, the levels should not exceed the limits for drinking water recommended by Committee II.

Ocean disposal may take two forms: 1) direct discharge into the sea via pipeline or other scheme, or 2) packaged discharge in concrete and steel drums before disposal at sea. Before use is made of either method, a thorough study of ocean movements, diffusion mixing, etc., should be made. Where direct disposal (unpackaged material) into the ocean is practicable, monitoring is necessary to determine the activity levels in marine biota, as well as to note the activity on sand grains where beaches may be used for recreational

purposes. In the disposal of packaged material at sea it has been recommended that such materials be discharged in waters having a depth of 1000 fathoms (approximately 2000 meters).

(iii) Solid wastes. Contaminated articles may be stored for decay or they may be disposed of by burial in the ground. The land-fill type of procedure, practiced in the disposal of municipal refuse and garbage, may be used. Contact with the ground water is to be avoided. No special precautions are taken in the burial of beta and gamma emitters, with the possible exception that concrete vaults may be used. In the case of alpha emitters, the practice is to cover these with concrete to avoid direct contact with the material should the disposal area be opened inadvertently. In all cases, however, the disposal area should be clearly defined and accurate records kept of the amounts and kinds of activity disposed of.

(3) Chemical processing of fuel. This subject is so extensive that the Committee prefers to make no specific statements regarding the handling and disposal practices used, since consideration has to be given to problems relating to the mining of the

ore, recovery of the fissionable material from the ore, concentration of the fissionable material, fuel element fabrication, spent fuel reprocessing, and handling and disposal of highly radioactive wastes. This whole problem will continue to be examined by the Committee and it is hoped that specific recommendations may be formulated for inclusion in subsequent editions of the Commission's report.

4. Sealed Sources

If sealed sources become broken or otherwise damaged, or are to be discarded for any reason, they should be returned either to the supplier or to the Atomic Energy installations. Under no circumstances should they be thrown into the trash or garbage.

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APPENDIX F, A. DETAILED DESCRIPTION OF TYPE 2 LABORATORY (INTERMEDIATE LEVEL FACILITY)

The material below constitutes an example of the type of specifications that might be needed in the case of the Type 2 laboratory. They are set forth to serve as a guide to the various factors to be considered and are not intended in the way of a specific recommendation. Circumstances will govern the specific facilities that will have to be provided.

1. The Facility

a. Rooms

These should be special rooms that are set aside for radioisotope work. If space permits, it is advisable to separate the laboratory from other space by a vestibule and sources should not be stored in this vestibule. Here can be kept special clothing, shoes, personnel monitoring devices, cleaning equipment, and washing facilities. The vestibule should be separated from the laboratory by a barrier, which serves to draw attention to the presence of an active area.

Depending upon the size of the installation under consideration, separate rooms or facilities may be provided for storage of radionuclides, hot laboratory facilities, storage of waste materials, chemical laboratory, and particularly in

the case of hospital facilities, an administration room, clinical measurements room, autoradiography facilities, etc.

b. Ventilation

The ventilation of the laboratory should be such that air from it cannot pass to other parts of the building. If air conditioning is required, the system should be such that air from fume hoods or glove boxes cannot be drawn into the building ventilation system.

There should be a fume hood, designed to provide a smooth flow of air and to avoid eddy currents.

The exhaust stack should proceed as directly as possible to the roof of the building; it should not be connected with any other non-radioactive system, and the exit should be located at a height of approximately 3 to 4 meters above the uppermost part of the building. The motor providing the air flow should be placed close to the exit, in order to produce a negative pressure in as long a length of the stack as possible. Although it is not considered necessary, it may be advisable to install a filter system near the junction of hood and stack. If a filter is installed, it should be so situated that it can be monitored and changed easily.

The inside of the fume hood should be covered with strippable paint. Gas, air, water, and electrical outlets should be controlled from the outside. It is advisable to install lights outside the hood, the light passing through a glass panel. The illuminating unit can thus be changed without having to enter the hood.

If gamma emitting isotopes are to be used in the hood, provision should be made for supporting the lead shielding.

c. Walls, floors, and ceiling

The walls and ceiling should be covered with a hard, non-porous washable paint. The floor should be covered with linoleum, rubber or vinyl tile, treated with a layer of hard wax and finally coated with a layer of solvent-soluble wax. This second layer is removed easily in the event of a spill. The junction of floor and wall should be rounded for easy cleaning.

d. Furniture

The furniture should be kept to a minimum and should be constructed of material that is easily cleaned. Drawers and cupboards should be as few as possible in order to prevent accumulation of dust. Bench surfaces should be covered with impermeable material such as formica, "arborite", stainless steel, or linoleum.

e. Plumbing

It is advisable to install a sink in or fume hood for the primary wash of very active glassware. In high level laboratories, this sink should drain into a double carboy system, which will prevent overflowing.

In addition there should be at least one large wash-up sink, equipped preferably with remote action faucets (knee, elbow, or foot) for cleaning glassware. The drain should proceed as directly as possible to a main sewer, and the traps should be accessible for periodic monitoring. There should be sufficient flow in this system to provide adequate dilution of any radioactive waste dumped down it.

Ordinary porcelain sinks are satisfactory, provided the bottom of the sink slopes slightly towards the drainage plug. It may be necessary to provide additional carboys if very active material is to be dumped down this sink.

f. Waste containers

The subject of waste disposal has been covered elsewhere (see Section IX. 3. b.); this section will deal only with the equipment necessary for collecting dry and liquid waste.

It is advisable to have a system whereby active waste is collected and transferred to storage to allow for decay to acceptable levels. Several containers should be available; foot-operated cans provided with non-porous bags are suitable for immediate disposal of dry waste. Larger cans with lids are useful for temporary storage and also for carrying material out for final disposal. Any can that will be removed from the laboratory should be clearly marked "RADIOACTIVE".

Liquid waste that is too active for disposal through the drains should be collected in carboys. It is advisable to connect two of these in series in order to avoid the possibility of overflow.

g. Special equipment

Special equipment suitable for the type and level of activity being used should be provided for each type of operation. This should include handling tools such as tongs, forceps, trays, and mechanical holders. Long-handled tools provide adequate protection by distance where millicurie amounts of beta or gamma activity are encountered. Semi-remote-control sampling and stirring devices should be included. Operations with larger amounts require the use of specially designed, remote-control equipment, including a shielded optical system (e.g., a periscope or mirror arrangement). When the isotopes concerned are primarily beta

emitters, efficient use can be made of transparent plastic shields fitting closely around the equipment to allow close handling with good visibility. Containers for the active material should incorporate the necessary shielding as close to the source as possible. Containers for liquid samples should always be reinforced by an outer, unbreakable container (3).

Glassware used in the radioisotope laboratory should be reserved for that purpose and should be suitably marked.

Equipment should be provided for remote pipetting of liquid - this should never be done by mouth. For low level work, simple hand-bulb or syringe pipettors are adequate, but more elaborate remote-controlled devices are necessary for medium and high level work.

When several sealed gamma-emitting sources are used, it is advisable to provide a lead-lined safe with lead filled trays. This permits the individual sources to be stored in holes in the lead of the tray. Separate compartments should be provided for different types of sources. Each compartment should be marked so as to permit immediate and certain identification of its contents from the outside. It is highly desirable that tubes, cells, needles, etc., be readily identifiable from a considerable distance as to their type and activity.

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The protection of the individual compartments and enclosures as a whole should be such that a person standing in front of the enclosure in performance of his duties receives in that time only a small fraction of the permissible dose.

2. Health Precautions

Regardless of the quantity or type of radioactive material that is to be used, there are certain safe practices that should always be followed.

a. Personal cleanliness

Work should be done over a tray lined with absorbent material. Work involving spray, fume or gas evolutions should be done in a hood. When work is completed, each person should individually clean any contaminated material, and if necessary arrange for its disposal. Trays and bench surfaces should also be cleaned after work. Rubber gloves should be worn while handling radioactive materials. The hands should be thoroughly washed and monitored before leaving the laboratory. There should be no eating and no smoking in the radioactive laboratory. Contact of the mouth with potentially contaminated articles should be avoided; for this reason radioactive material should never be pipetted by mouth. Glassblowing should be avoided in a radioisotope laboratory.

Every effort should be made to discourage sucking of objects such as pencils and fingers.

b. Clothing

The degree of protection required depends on the amount of activity used. Even tracer amounts should be handled with laboratory coats protecting normal attire. Where routine radiochemical or biological work is done, coveralls or other clothing that completely clothe the body should be worn and must be restricted to this operation. Rubber gloves should be worn while handling active materials which may give rise to contamination of the hands. If the material is spilled on the floor, special cloth or rubber overshoes should be used. In some cases, the provision of shoes to be used only in the laboratory is preferable.

Good protective practice in many respects is similar to, but usually less stringent than, that employed in the manipulation of virulent bacteriological organisms.

c. Instruments

Instruments are necessary to detect the presence of radiation. Every laboratory using open sources of radioactive material should have a Geiger counter for qualitative estimation of contamination.

When gamma-emitting sources of 100 mc or more are used, there should be an ionization chamber of the rate-meter type, for measuring the intensity of the radiation field.

The latitude that may be applied in the operational and administrative control of occupational exposure will be dictated by two major factors (a) the type of risk involved and the likelihood of the occurrence of over-exposures, and (b) the monitoring methods, equipment, and the dose recording procedures available to the radiation users. Where the hazards are minimal and not likely to change from day to day, the integration may be carried out over periods of 1 to 3 months. Where the hazards are significant and where the exposure experience indicates unpredictability as to exposure levels, the integration should be carried out more frequently, such as weekly, daily, or even hourly.

d. Contamination control

A routine system of surveying for contamination control should be established, and appropriate instruments and techniques should be used for the particular material involved. Attention should be paid not only to possible contamination of the laboratory itself, but also to people and articles leaving the laboratory. No person or object should leave a radioisotope laboratory without proper monitoring beforehand (3,4,5,).

An essential feature of contamination control is regular and proper cleaning of the active area. Cleaning should be done by someone aware of the need for taking precautions - ordinary janitor or char services are usually not suitable for this purpose.

Cleaning equipment (mops, brushes, rags, buckets, wax, soap, etc.) should be restricted to the laboratory and not used elsewhere. Floors and benches should be cleaned by wet or oil mopping and dusting only. Dry mopping, brushing or dusting should be avoided, since this may create a dust hazard.

e. Emergencies

All isotope laboratories should have a plan of what to do in the case of an emergency, and all personnel should be familiar with these procedures.

Certain basic equipment should be available for use in an emergency. This should include suitable respirators for radioactive work, coveralls, caps, thick rubber gloves, and rubber overshoes. Large bags made of heavy paper are useful for quick disposal of contaminated material. Several rolls of masking tape should be available, for sealing off a room contaminated by active vapors, gases, or mists.

Equipment for carrying out simple decontaminations should be kept in readiness. This might include mops with several heads, a mop pail with an attached squeezing device, expendable scrub brushes, a generous supply of rags, several boxes of detergent and cleansing agent, solvents, and one of the specially devised agents for removing radioactive contamination. An acrylic spray "Bomb" may be useful for sealing contamination to a surface.

f. Medical examination

Reference is made to the section on Health Surveillance under item VIII of the Introduction to the 1954 I.C.R.P. Report (1).

APPENDIX F. B. EXAMPLE OF REGULATIONS FOR DEALING WITH A MAJOR SPILL

(1) Notify all other persons in the affected laboratory.

(2) Evacuate all staff except those required to deal with the spill. No person from the affected laboratory may proceed far into the inactive area until he has been monitored and found free from dangerous contamination. This does not apply in case of injured personnel, but if possible their protective clothing should be left in the laboratory.

(3) a. If the spill is on skin, flush thoroughly with water.

b. If the spill is on clothing, remove affected clothing and leave in the contaminated room.

(4) Stop all operations, the continuance of which would add to the contamination.

(5) Notify the radiation safety officer and the officer-in-charge of the department.

(6) Attach a danger notice to the barrier to warn others not to enter the contaminated area inadvertently.

(7) Make a plan for decontaminating the affected area. Seriously consider each action to be taken. Incorrect procedures may result in more harm than good.

(8) While these emergency measures are being carried out, persons involved in the spill should be decontaminated. If normal washing procedures do not suffice to reduce contamination below the required level (see Appendix F. C.) the procedure given under Personnel Decontamination (VI. 2.) should be undertaken.

(9) Before re-entering the area to carry out decontamination, suitable protective clothing should be put on, the nature of which will vary with the type of accident but will normally include coveralls, gloves, overshoes, and breathing masks.

(10) Normal work may not be resumed until a radiation survey has shown that it is safe to do so and the approval of the officer-in-charge has been given.

APPENDIX F. C. SUGGESTED VALUES FOR SURFACE CONTAMINATION

There is no general agreement on suggested levels for surface contamination, and such agreement cannot be obtained at this time. To provide some information for guidance, however, the Committee has summarized the levels used at various laboratories in Table F. C. I. These are presented as a guide to keep from obtaining over-exposures in terms of the body burden. It will be noted that variations exist in the suggested values listed, due to possible differences in the techniques of measurement and the type of instrumation used.

To convert from one system of units to another, one will have to obtain data using calibrated sources along with the types of instrumentation used for making the specific measurements. With the proper choice of instrumentation (limited in sensitivity to the background level), one can detect the suggested levels of contamination. Most alpha meters are calibrated to read in disintegrations or counts per minute which can be related to the $\mu c/cm^2$ of the detected area. Gamma survey instruments are generally calibrated in mr/hr which can be related to curie units. In the case of the beta dose, the standard procedure is to read the beta dose in mr/hr on a gamma calibrated instrument. Since a beta-gamma detector will record nearly all beta activity reaching the sensitive element, a crude estimate of the activity can be obtained in counts per minute. (For example, for many G-M tubes, a reading of 0.2 mr/hr is approximately equivalent to 600 counts per minute).

In some instances, where the background may be high, smears or swipes may be preferred to direct instrumental measurements. With care, reproducible and reasonably accurate results may be obtained by such techniques. If a standard area is chosen for test, and the sample is counted with known efficiency on a G-M or other laboratory counting instrument, the d/m/unit area of removable contamination may be determined.

TABLE F. C. I. Suggested levels of surface contamination

Site	Oak Ridge I	NCRP Handbook[4] II	British AERE III	British Code of Practice IV	Chalk River[e] V
	(in $\mu c/cm^2$ units except as noted)		(in $\mu c/cm^2$ units)	(in $\mu c/cm^2$ units)	(in $\mu c/cm^2$ units)
Hands and other parts of body	α - 2.5×10^{-7} β - 0.3 mrep/hr	0.1 mrep/hr (a) 1.0 mrep/hr (b)	α - 3×10^{-6} β - 10^{-4}	α - 10^{-5} } (a) β - 10^{-4} } 10^{-4} (b)	α 10^{-6} β-γ - 10^{-4}
Clothing	α - 0.68×10^{-6} β - 0.18 mrep/hr	Same as above	None given	Same as above	α - 10^{-6} β-γ-5×10^{-4}
Protective clothing, glassware, tools, objects to be handled with bare hands	Direct Reading α - 1.35×10^{-6} β - 0.25 mrep/hr Indirect Reading α - 1.35×10^{-7} β - 4.5×10^{-6}	Same as above	α - 3×10^{-5} β - 10^{-3}	α - 10^{-4} } β - 10^{-3} } (a) 10^{-3} (b)	α - 10^{-6} β-γ - 10^{-3}
"Active" areas	Same as above	Same as above	Widespread Areas α - 10^{-5} (c) α - 10^{-4} (d) All β - 10^{-4} Limited Areas α - 10^{-4} (c) α - 10^{-3} (d) All β - 10^{-3}	Same as above	α - 10^{-5} β-γ clean on swipe. Less than 2 mr/hr on contact
"Inactive" areas	Direct Reading α - 1.3×10^{-6} β - 0.05 mrep/hr Transferable α - 2.7×10^{-6} β - 0.9×10^{-6}	Same as above	α - 10^{-4} (c) α - 10^{-3} (d) All β - 10^{-3}	α - 10^{-5} } (a) β - 10^{-4} } 10^{-4} (b)	α - 10^{-6} β-γ - 10^{-5}

(a) Very hazardous radioisotopes
(b) Other
(c) Hazardous
(d) Other
(e) See page 78 A

(e) Chalk River - The fundamental test is that the surface must be "clean on swipe" and swipe tests cannot be expressed as $\mu c/cm^2$. The background in the active areas is such that 10^{-4} $\mu c/cm^2$ β-γ could not be measured with our instruments. With these provisos the nearest values that could be indicated that conform with the others listed are those shown in this column.

Additional notes to accompany Table F. C. I.

A maximum contamination level of 1 mrep/hr average, as measured in a small volume of air (in a thin layer) above any 2-sq. in. area of the body, if due to a gamma-emitting radioisotope corresponds very approximately (energy of radiation, self-shielding, geometry correction, Geiger-Muller tube characteristics, relative amount of beta and gamma present change this value) to a reading of about 1,000 counts per minute when a Geiger counter (with a flat plate area of 2-sq. in.) is placed as close as possible to the contaminated area. Levels of contamination of the most hazardous radionuclides should not exceed 0.1 mrep/hr (or < 100 counts per minute).

The Radiation Monitor, A.E.R.E. type 1021B, is a typical contamination monitor. The standard probes are a scintillation α-counter and a G.M. β-counter, type B.12, in a protective housing.

10^{-4} $\mu c/cm^2$ (α-rays) = 3 to 10 counts/sec. (with α-probe);

10^{-4} $\mu c/cm^2$ (1 Mev β-rays) = 5 counts/sec. (β-probe).

The mica-windowed counter type EHM2 can be used for both α- and β-monitoring. Discrimination against β-rays can be obtained by operating the counter between 5 and 20 volts below the threshold of the β-plateau. The α-sensitivity then depends sharply upon the operating voltage.

10^{-4} $\mu c/cm^2$ (α-rays) = 0.3 to 1.0 counts/sec.

10^{-4} $\mu c/cm^2$ (β-rays) = 1.5 counts/sec.

The β-probe of the monitor type 1021B can also be used to estimate dose-rates.

For γ-rays between 0.3 and 3 Mev: ~1 mr/hr = 80 counts/sec.

For 1 Mev β-rays in a unidirectional beam, e.g., from a point source at a distance: 1 mrad/hr (delivered to soft tissue) = 50 counts/sec.

Note. -- This probe cannot be used to measure β-ray dose rates at a surface directly because it views only part of the surface and because the counter is about 2 cm away from the surface.

HISTORY OF THE INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION (ICRP)

LAURISTON S. TAYLOR

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Abstract—The ICRP was established by the second International Congress of Radiology in 1928. Since this time the Commission has established the basic pattern for radiation protection recommendations that have gone into use thoughhout the world. The first quantitative value of permissible dose was promulgated in 1934 and remained in effect until 1950. In 1950 the MPD was lowered by a factor of about 2, and in 1956 it was again lowered by a factor of about 3. In addition to the development of the basic concept of MPD, the Commission has also adopted maximum permissible concentrations of radioactive materials in air and water and the whole body. The discussion below outlines the various steps that have taken place in the development of radiation concepts since the establishment of the Commission just 30 years ago.

1. FORMATION

THE ICRP was formed in 1928 under the auspices of the Second International Congress of Radiology then meeting in Stockholm. The formation of an international protection committee had been discussed by the First Congress in 1925 but no active steps had been taken at that time toward this end.

During the Second Congress, initial plans for organizing an international protection committee were developed by G. W. C. KAYE and S. MELVILLE (Great Britain), and L. S. TAYLOR (U.S.). Dr. G. GROSSMAN (Germany) and Dr. R. SIEVERT (Sweden) were brought into the discussions and plans were completed for the organization of a committee. Their proposals and organization plans were presented to the Second International Congress and were approved. The committee was named the International X-ray and Radium Protection Committee, and its membership consisted of the five individuals who planned the organization.

2. MODE OF OPERATION AND HISTORY

Because of the early experience of the ICRU with its large and unwieldy membership, the Committee decided at the outset to keep its membership as small as possible. It also decided to include in its membership only people who were working actively in the general field of radiation protection. For this reason, the initial Committee consisted of only five persons. This was enlarged for the next Congress by adding Dr. I. SOLOMON of France and Dr. CERESOLE of Italy.

The ICRP, because of its small size, was operated much more informally than the ICRU. The chairman from 1928 through 1937 was Dr. G. W. KAYE, then of the National Physical Laboratory, and the honorary chairman Dr. S. MELVILLE. It might be remarked (with some interest in view of later events) that at the time of its formation the problem of radiation protection was not considered to be as important or as serious as that of radiation units. Members of the ICRP felt that the problem would grow and sought to be prepared.

1928

The Committee held its initial meeting in 1928 for the purpose of adopting some interim protection regulations. Until that time, the only clearly formulated recommendations were those prepared a few years earlier by the British Committee.[1] These were used as a basis for discussion. The first recommendations of the

Committee[2] were very similar to the early British proposals, and until 1950 its recommendations were patterned around these early British recommendations.

1931

The second meeting of the Committee took place in Paris in 1931 and was attended by all seven members. At this meeting, there was some discussion of the possibility of introducing so-called tolerance levels of radiation for radiation workers. This was recognized as desirable, but with very little evidence to go on, no specific recommendations were made.[3]

1934

The third meeting took place in Zurich in 1934 and was again attended by all seven members. This meeting was notable because there was established for the first time a permissible level of radiation exposure. This was related to the newly established unit of X-ray dose—the roentgen. The level then set was 0.2 r/day.[4] (It might be noted that the year following this, the National Committee on Radiation Protection in the United States recommended a lower level of 0.1 r/day.)

1937

The fourth meeting was held in Chicago in 1937 with five of the original seven members attending.

Throughout the period 1928 through 1937, the main work of the Committee consisted of gradually enlarging and extending the recommendations originally developed at its first meeting. Until then, the main item of the protection recommendations was the specification of the thicknesses of barriers of various materials that should be interposed between a source and an individual in order to assure adequate protection. Prior to the establishment of the permissible dose in 1934, these barrier thicknesses had been somewhat arbitrary. In 1934 and again in 1937,[5] the relationship of the barrier thickness to the actual dose in roentgens was clarified and was put on a sound quantitative basis.

Following the deaths of both the chairman and the honorary chairman, L. S. TAYLOR acted as secretary for the Committee until its next meeting which was not to occur until 1950.

Under circumstances similar to those of the ICRU, the ICRP was reorganized in 1950 on a different basis from that which prevailed before the war. By that time, the questions of radiation protection had assumed far greater importance than they had earlier. This, of course, was due to the advent of atomic energy. The Committee was enlarged in size to twelve members in order to better deal with the problems facing it. The new membership was made up of individuals having recognized standing in the field without regard to nationality, and its operating rules were made the same as those of the ICRU. At this time, its name was changed to International Commission on Radiological Protection.

1950

The ICRP held its fifth meeting in London in 1950, attended by nine members and a chairman. Between 1946 and 1950, a large body of protection information had been prepared by the NCRP in the United States, having to do with exposure of the whole body to radiation from both external and internal sources. The NCRP had also developed considerably more details in the general field of X-ray protection. This large background of information was used as a basis for discussions of the ICRP which resulted in the development of its 1950 report. It should be mentioned that an extensive interchange of this information had previously been accomplished through the medium of the Tripartite Conference between the United States, Canada, and England. The results of these conferences were in turn based to a considerable extent on data developed during the Manhattan District days.

With the availability of this new information, the ICRP lowered the maximum permissible dose for radiation workers from 0.2 r/day (in use since 1934) to 0.3 r/week. The report[6] also included for the first time maximum permissible concentrations in the body of approximately ten radioactive isotopes.

Because of the very large task confronting it, the IRCP established subcommittees to deal with special phases of the radiation protection

problem. This arrangement has greatly facilitated the development and presentation of information.

The ICRP adopted for the first time a set of rules governing the selection of members and the work of the Commission. These were in agreement with the rules adopted at the same time by the ICRU.[6]

1952

An interim meeting of the ICRP was held in Stockholm in 1952, with the ICRU and the UNESCO Joint Committee on Radiobiology. At this time, the major subject under consideration was the possible genetic effects of radiation. The meeting was attended by a number of geneticists from several countries. At this time, it was recognized that the genetic effects of radiation were becoming better understood and should be taken into consideration. Figures were discussed for an average per capita dose for a large population. The proposals for an average per capita gonadal dose ranged from 3 r (U.K.) to 20 r (U.S.) and a middle value of 10 r was informally accepted. These were in addition to natural background radiation. However, because there was very little agreement between the geneticists themselves, and because of the meager information available on this question, it was decided not to make any specific recommendations. (It is interesting to note, however, that the recent recommendations made on this question in April 1956 by the ICRP and later by the National Academy of Sciences (U.S.) and the Medical Research Council (U.K.) give approximately the same range of figures as those discussed at the Stockholm meeting in 1952.)

1953

The sixth meeting of the ICRP was held in Copenhagen in 1953. This was a joint meeting with the ICRU and was held during the week preceding the opening of the International Congress. Most of the representatives on the subcommittees also met.

The report of the Commission[7] as developed during these meetings marked a radical departure from all others. Its total size was 92 pp. and it included a great amount of detail never before agreed upon on an international basis.

The main body of the report consisted essentially of the reports of its five subcommittees:

(1) Permissible Dose for External Radiation.
(2) Permissible Dose for Internal Radiation.
(3) Protection against X-rays Generated at Potentials up to 3 MV.
(4) Protection against X-rays above 3 MV, β-rays, γ-rays, and Heavy Particles including Neutrons and Protons.
(5) Handling and Disposal of Radioactive Isotopes.

The recommendations on permissible dose from external radiation were somewhat broadened over those previously made, but the basic permissible exposure level of 0.3 r/week was reaffirmed.

Subcommittee 2 gave the maximum permissible concentrations of radioactive materials in the body, air, and water for nearly 100 radioactive isotopes, and included a large body of reference material.

Subcommittee 3 produced a very detailed report applying to both medical and industrial radiology, and included recommendations regarding radiation levels from special devices such as television receivers.

Subcommittees 4 and 5 issued brief reports; much of the material in their areas was still in an unsatisfactory state at that time.

With the development of this detailed report, a new problem arose. Previously the reports had been relatively short and could be published as a few pages in any of the technical journals. However, this report was too large to be published in this manner, and for some time there was uncertainty as to whether or not it could be published in its entirety. Eventually it was published as a supplement to the *British Journal of Radiology*.[7] This had to be underwritten, and for this purpose, some funds were obtained from the British Electrical Industry.

Further difficulty arose because of the expense of carrying out the duties of the secretariat of the ICRP. This expense was borne first by the National Physical Laboratory and then by the British Medical Research Council. All other expenses of the operation were handled

on a voluntary basis with the parent organization of the individual members bearing their expenses.

1956

The seventh meeting of the ICRP took place in Geneva in March 1956, and was held jointly with the ICRU over a period of 12 days.

The report developed in 1953 was not changed in principle. However, greater emphasis was placed on the earlier cautions to keep radiation exposure levels as low as possible regardless of the weekly limits permitted. It was specifically recommended[8,9] that the accumulated exposure of occupational workers be kept below 50 rems up to age 30, and that for the same period the average per capita dose for the population be limited to about 10 rems in addition to background. The compilation of permissible concentrations of radioactive isotopes in the body and in air and water was considerably enlarged to include nearly 200 radioactive isotopes. A new subcommittee was established, in place of the former Subcommittee 5, to deal with the problems of radioactive waste disposal.

During these meetings, the Commission's affiliation with the World Health Organization as a "non-governmental participating organization" in the WHO program was ratified. This affiliation came about as a result of contacts made in the fall of 1955 between the World Health Organization and the ICRP with a view to determining if the latter would participate in the WHO activities. The matter was taken up with the members by correspondence, and it was agreed that the ICRP should give its assistance to WHO. Under the arrangement made, the WHO will not influence the operation of the ICRP but will look to it for guidance in matters of radiation protection.

During the meetings, the relationships between the ICRP and the ICRU were more firmly established. They have always operated as separate commissions but since their inception they have always met at the same time and have maintained close collaboration. There has also been a certain degree of overlap in membership. There is now a clear statement of policy that the two Commissions will work together and consult one another on matters of common interest.

There were also extensive discussions regarding the possibility of forming an International Protection Organization, to be privately financed so as to avoid any nationalistic or political influence. If such an organization were formed, the ICRU and ICRP would be blended into the one organization. No attempt was made to work out the details of such an arrangement, but no difficulties in doing this are foreseen.

It was agreed that if such an organization were established, it should have some semi-official ties with WHO and UNO, without becoming a part of their organization or subject to their direct control. It is felt that one of the strongest points of both Commissions is their freedom to select membership without regard to matters of national politics or other such influences.

Following the meetings of the ICRP in Geneva, a 3½ day joint session was held by some of its members, some members of the ICRU, and representatives from the WHO. The main purpose of this meeting was to outline to WHO the nature of the ICRP work and to point out ways in which WHO might assist in the worldwide implementation of the recommendations of the Commission. A number of specific recommendations were made to WHO and it is believed that they are taking steps to follow these through.

As of the time of writing, the full 1956 report of the Commission has not been officially released.[10] There is again the problem of financing the publication costs. In this connection, WHO has offered to indirectly subsidize the publication by guaranteeing the purchase of 500 copies of the report; this will offset the cost to some extent.

As a result of an inquiry from the United Nations Scientific Committee on the Effects of Atomic Radiation, an emergency joint meeting of the ICRP and ICRU was held in New York from 31 October to 6 November 1956. At this time the Commissions received the following formal resolution from the UNSC and agreed to comply therewith:

(a) To consider and discuss the question of

how to arrive at reliable data indicating the doses to different parts of the body (particularly the gonads) received by individuals and, in the aggregate, by large population groups due to the medical use* of ionizing radiations.

(b) To examine what recording system, if any, is at present feasible for the determination of the relevant dose values; and

(c) As a result of these studies, to submit to the Scientific Committee on the Effects of Atomic Radiation as soon as possible, and in any event before 1 September 1957, a report upon their deliberations and conclusions on the subjects (a) and (b), and to make any appropriate recommendations.

To facilitate the study, the UNSC provided the Commissions with the sum of $8000 for partial defrayment of travel costs and administrative expenses.

To carry out the study a special study group was made up of members from each Commission. Parallel task groups, operating under leadership of the two Commissions, were set up in a number of individual countries. Secretary of the Special Study Group was E. E. SMITH acting in behalf of W. BINKS. Preliminary results of the study were completed by March 1957 and included relatively complete reports from twelve countries.

A meeting of the Study Group was held in Geneva from 23 April to 1 May 1957, at which time the consolidated final report was completed except for editorial details. It was circulated twice to all members of the main commission of the ICRP and ICRU for final approval and was then forwarded to the UNSC before the deadline of 1 September 1957. The report was published within a short time.[11]

As noted earlier, the ICRP and ICRU were established and thereafter sponsored by the International Congresses of Radiology. In a sense the two Commissions were the only continuing bodies of the congresses since the latter existed technically only every 3 years. To some degree, this was awkward for the Commissions in that their sponsorship appeared to be uncertain. This situation was alleviated by the organization of the International Society of Radiology in 1956. This society will in the future, sponsor the International Congresses of Radiology, the ICRP and the ICRU. By its own international character its sponsorship of the Commissions will carry more weight. As a further outgrowth of the new organization it has made funds available to the Commissions to assist in their work. This will be continued in the future and the amounts will probably increase as the Society membership grows.

* For the purpose of this report, and in order to include all types of diagnostic and therapeutic exposure to ionizing radiation, the term "medical use" is extended to apply to all types of medical exposure (except occupational) and the term "radiation practitioner" is used to include radiologists, general practitioners, dentists, obstetricians, osteopaths, chiropractors, etc., who administer medical exposure to ionizing radiation.

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11. Exposure of man to ionizing radiation arising from medical procedures, *Phys. Med. Biol.* **2,** 107 (1957).
12. *Hearings before the special Subcommittee on Radiation of the Joint Committee on Atomic Energy, Congress of the U.S.*, pp. 851–852. (U.S. Government Printing Office (1957).)

ADDENDA

1. *Formal meetings of the ICRP*

Listed below are the formal meetings of the ICRP held since its inception, the number of members in attendance, and the Commission

Date and place of meeting	Members Present	Officers
1928, Stockholm	5	G. W. C. KAYE (U.K.), Chariman
1931, Paris	7	G. W. C. KAYE (U.K.), Chairman
1934, Zurich	7	G. W. C. KAYE (U.K.), Chairman
1937, Chicago	7	G. W. C. KAYE (U.K.), Chairman
1950, London	9	Sir E. ROCK-CARLING (U.K.), Chairman L. S. TAYLOR (U.S.), Secretary
1952, Stockholm	7	Sir E. ROCK-CARLING (U.K.), Chairman L. S. TAYLOR (U.S.), Secretary
1953, Copenhagen	12	Sir E. ROCK-CARLING (U.K.), Chairman W. BINKS (U.K.), Secretary
1956, Geneva	12*	Sir E. ROCK-CARLING (U.K.), Chairman W. BINKS (U.K.), Secretary
1956, New York (with ICRU)	9	R. SIEVERT (Sweden), Chairman G. FAILLA (U.S.), Vice-chairman L. S. TAYLOR (U.S.), Co-chairman E. E. SMITH (U.K.), Acting Secretary

* Main Commission only. Subcommittee membership totalled approximately 50 and a substantial number were in attendance.

Officers. (Officers listed were in office at the time of meeting. Terms of new officers begin after confirmation of their election during the International Congress, and continue for a 3 year period corresponding to the interval between Congresses. Honorary chairman are not listed.)

The Eighth International Congress of Radiology is scheduled to meet in Munich in 1959. The next formal meeting of the ICRP has not been scheduled but will probably be held prior to the Congress. For the period 1956–1959, the officers of the Main Commission are R. SIEVERT (Sweden), Chairman; G. FAILLA (U.S.), Vice-chairman; B. LINDELL, (Sweden) Acting Secretary.

2. *Members preparing reports of the ICRP*

1956–57, New York and Geneva
(Special study for UNSC)

R. M. SIEVERT, Chairman ICRP (Sweden)
G. FAILLA, Vice-chairman ICRP (United States)
E. E. SMITH, Acting Secretary ICRP (Great Britain)
L. S. TAYLOR, Chairman ICRU (United States)
L. H. GRAY, Vice-chairman, ICRU (Great Britain)
H. O. WYCKOFF, Secretary ICRU (United States)
A. ALLISY (France)
W. G. MARLEY (Great Britain)
K. Z. MORGAN (United States)
E. A. WATKINSON (Canada)
(Note: The report was prepared by the above special Study Group but was approved by the Main Commissions of both ICRP and ICRU).

1956, Geneva

Sir E. ROCK-CARLING, Chairman (Great Britain)
W. BINKS, Secretary (Great Britain)
L. BUGNARD (France)
G. FAILLA (United States)
H. HOLTHUSEN (Germany)
J. C. JACOBSEN (Denmark)
R. G. JAEGER (Germany)
W. V. MAYNEORD (Great Britain)
K. Z. MORGAN (United States)
R. M. SIEVERT (Sweden)
R. S. STONE (United States)
L. S. TAYLOR (United States)

1953, Copenhagen

Sir E. ROCK-CARLING, Chairman (Great Britain)
J. C. JACOBSEN, Hon. Chairman (Denmark)
W. BINKS, Secretary (Great Britain)
A. J. CIPRIANI (Canada)
G. FAILLA (United States)
H. HOLTHUSEN (Germany)
R. G. JAEGER (Germany)

W. V. Mayneord (Great Britain)
K. Z. Morgan (United States)
R. M. Sievert (Sweden)
R. S. Stone (United States)
L. S. Taylor (United States)
M. Tubiana (France)

1950, London

Sir E. Rock-Carling, Chairman (Great Britain)
L. S. Taylor, Acting Secretary (United States)
W. Binks (Great Britain)
E. L. Cherigie (France)
A. J. Cipriani (Canada)
R. G. Jaeger (Germany)
W. V. Mayneord (Great Britain)
R. R. Newell (United States)
R. Sievert (Sweden)

1937, Chicago

G. W. C. Kaye, Hon. Secretary (Great Britain)
H. Behnken (Germany)
E. Pugno-Vanoni (Italy)
I. Solomon (France)
L. S. Taylor (United States)

1934, Zurich

R. Ledoux-Lebard, Hon. Chairman (France)
F. Tank, 1st Hon. Chairman (Switzerland)
R. Bär, 2nd Hon. Chairman (Switzerland)
G. W. C. Kaye, Hon. Secretary (Great Britain)
H. Behnken (Germany)
R. Sievert (Sweden)
I. Solomon (France)
L. S. Taylor (United States)
E. Pugno-Vanoni (Italy)

1931, Paris

R. Ledoux-Lebard, President (France)
R. Sievert, Hon. President (Sweden)
G. W. C. Kaye, Hon. Secretary (Great Britain)
S. Melville, Hon. Secretary (Great Britain)
G. Grossman (Germany)
E. Pugno-Vanoni (Italy)
I. Solomon (France)
L. S. Taylor (United States)

1928, Stockholm

G. W. C. Kaye, Hon. Secretary (Great Britain)
S. Melville, Hon. Secretary (Great Britain)
L. S. Taylor (United States)
G. Grossman (Germany)
R. Sievert (Sweden)
I. Solomon (France)

3. *Major Steps in the development of protection standards*[12]

1925 ICRU established by First International Congress of Radiology. Maximum permissible dose = 0.1 erythema dose/year = 50–100 r/year (only visible signs of radiation reaction).

1928 ICRP established by Second International Congress of Radiology
(a) First set of international protection recommendations adopted.
(b) First unit of dose adopted: the roentgen (r).

1929 NCRP formed in the U.S.

1931 X-ray protection rules produced by NCRP (H 15).

1934 ICRP:
(a) Adopted first permissible dose of 0.2 r/day (= 72 r/year).
(b) Based on erythema dose.

1935 NCRP:
(a) Adopted value of 0.1 r/day for maximum permissible dose (MPD) (= 36 r/year).
(b) More conservative MPD adopted on basis of their suspected other effects.
(c) First discussions on genetic effects.

1947 NCRP:
(a) Lowered MPD to 0.3 r/week (= 15 r/year).
(b) Lowered because of animal experience in Manhattan District studies.
(c) Genetic effects considered (see H 59).
(d) Longevity effects considered.
(e) Large population effects considered.
(f) Standards still based mainly on absence of detectable injury to individuals.

1950 ICRP:
(a) Adopted MPD = 0.3 r/week.
(b) Used values of NCRP for standards for external irradiation.
(c) Used unpublished values of NCRP for internal emitters (see H 47).

1952 ICRP/ICRU:
(a) Held first conference on genetic effects.
(b) Reached conclusions essentially as recommended by ICRP in April 1956 and NAS in June 1956.
(c) Felt there was no need to rush to lower levels—better to wait for better data.

1953 NCRP—listed maximum permissible concentration MPC for 100 radioisotopes (H 52).

1953 ICRP:

(a) Adopted NCRP listings of MPC for 100 radioisotopes.

(b) Recommended 1/10 levels for large population groups.

1953 ICRU—adopted unit of absorbed dose (rad).

April 1956 ICRP—Introduced accumulated dose concept for both occupational and whole population exposure.

June 1956 NAS/BMRC—made same general recommendations as ICRP (Natural in view of substantial overlap of membership).

January 1957 NCRP:

(a) Formulated the age-prorated occupational dose to insure proper distribution with age.

(b) Population dose concept of ICRP adopted.

April 1957 ICRP/ICRU:

(a) In work for UNSC made recommendations on population exposure evaluations by sampling techniques.

(b) Tentatively decided that somatic damage is more immediately important than genetic damage.

March, 1958 ICRP:

Met in New York to clarify April 1956 recommendations and prepare final report.

October 1957

MEMBERS OF THE ICRP - 1959

Main Commission

Sir Ernest Rock Carling,
Chairman emeritus (Great Britain)

R. M. Sievert, Chairman (Sweden)

G. Failla, Vice Chairman (U.S.A.)

W. Binks, Secretary[1] (Great Britain)

L. Bugnard (France)

H. Holthusen (Germany)

J. C. Jacobsen (Denmark)

R. G. Jaeger (Germany)

W. V. Mayneord (Great Britain)

K. Z. Morgan (U.S.A.)

R. S. Stone (U.S.A.)

L. S. Taylor (U.S.A.)

E. A. Watkinson (Canada)

Committee I (Permissible dose for external radiation)

G. Failla, Chairman (U.S.A.)

A. R. Gopal-Ayengar (India)

G. Bonnier (Sweden)

L. Bugnard (France)

D. G. Catcheside (Great Britain)

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1) Mr. Binks resigned as Secretary in 1957, for health reasons. After his resignation E. E. Smith (Great Britain) served as Acting Secretary, and since August 1, 1957, B. Lindell (Sweden) has served as Temporary Secretary

Committee I (continued)

J. C. Jacobsen (Denmark)

T. Kemp (Denmark)

R. Latarjet (France)

J. F. Loutit (Great Britain)

H. J. Muller (U. S. A.)

Jens Nielsen (Denmark)

R. M. Sievert (Sweden)

R. S. Stone (U. S. A.)

Shields Warren (U. S. A.)

Committee II (Permissible dose for internal radiation)

K. S. Morgan, Chairman (U. S. A.)

W. Binks (Great Britain)

A. M. Brues (U. S. A.)

W. H. Langham (U. S. A.)

L. D. Marinelli (U. S. A.)

W. G. Marley (Great Britain)

M. K. Nakaidzumi (Japan)

G. J. Neary (Great Britain)

M. N, Pobedinski (U.S.S.R.)

E. E. Pochin (Great Britain)

C. G. Stewart (Canada)

Committee III (Protection against X-rays up to energies of 3 MeV and beta and gamma rays from sealed sources)

R. G. Jaeger, Chairman (Germany)

E. E. Smith, Vice Chairman (Great Britain)

S. Benner (Sweden)

J. Bouchard (Canada)

C. B. Braestrup (U. S. A.)

B. Combee (Netherlands)

C. Garrett (Canada)

T. Gauwerky)(Germany)

H. Holthusen (Germany)

P. Rønne (Denmark)

D. J. Stevens (Australia)*

H. O. Wyckoff (U.S.A.)

Zakovsky (Austria)

A. Zuppinger (Switzerland)

Technical Secretary: W. Hübner (Germany)

Committee IV (Protection against electromagnetic radiation above 3 MeV and electrons, neutrons and protons)

H. E. Johns, Chairman (Canada)

J. S. Mitchell, Vice Chairman (Great Britain)

L. H. Gray (Great Britain)

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*From March, 1958

Committee IV (continued)

F. Hercik (Czechoslovakia)

G. Joyet (Switzerland)

W. H. Koch (U.S.A.)

J. S. Laughlin (U. S. A.)

W. V. Mayneord (Great Britain)

C. A. Tobias (U. S. A.)

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Radioactive-Waste Disposal in the Ocean

Recommendations of the
National Committee on Radiation Protection

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Preface

The Advisory Committe on X-ray and Radium Protection was formed in 1929 upon the recommendation of the International Commission on Radiological Protection, under the sponsorship of the National Bureau of Standards, and with the cooperation of the leading radiological organizations. The small committee functioned effectively until the advent of atomic energy, which introduced a large number of new and serious problems in the field of radiation protection.

At a meeting of this committee in December 1946, the representatives of the various participating organizations agreed that the problems in radiation protection had become so manifold that the committee should enlarge its scope and membership and should appropriately change its title to be more inclusive. Accordingly, at that time the name of the committee was changed to the National Committee on Radiation Protection. At the same time, the number of participating organizations was increased and the total membership considerably enlarged. In order to distribute the work load, ten working subcommittees have been established, as listed below. Each of these subcommittees is charged with the responsibility of preparing protection recommendations in its particular field. The reports of the subcommittees are approved by the main committee before publication.

The following parent organizations and individuals comprise the main committee:

American College of Radiology: R. H. Chamberlain and G. C. Henny.
American Medical Association: P. C. Hodges.
American Radium Society: E. H. Quimby and T. P. Eberhard.
American Roentgen Ray Society: R. R. Newell and J. L. Weatherwax.
National Bureau of Standards: L. S. Taylor, Chairman, and M. S. Norloff, Secretary.
National Electrical Manufacturers Association: E. D. Trout
Radiological Society of North America: G. Failla and R. S. Stone.
U. S. Air Force: S. E. Lifton, Maj.
U. S. Army: J. P. Cooney, Brig. Gen.
U. S. Atomic Energy Commission: K. Z. Morgan and J. C. Bugher.
U. S. Navy: C. F. Behrens, Rear Adm.
U. S. Public Health Service: H. L. Andrews and E. G. Williams.
Representatives-at-large: Shields Warren and H. B. Williams.

The following are the subcommittees and their chairmen:

Subcommittee 1. Permissible Dose from External Sources, G, Failla.
Subcommittee 2. Permissible Internal Dose, K. Z. Morgan.
Subcommittee 3. X-rays up to Two Million Volts, H. O. Wyckoff.
Subcommittee 4. Heavy Particles (Neutrons, Protons, and Heavier), H. H. Rossi.
Subcommittee 5. Electrons, Gamma Rays, and X-rays Above Two Million Volts, H. W. Koch.
Subcommittee 6. Handling of Radioactive Isotopes and Fission Products, H. M. Parker.
Subcommittee 7. Monitoring Methods and Instruments, H. L. Andrews.
Subcommittee 8. Waste Disposal and Decontamination, J. H. Jensen.
Subcommittee 9. Protection Against Radiations from Radium, Cobalt-60, and Cesium-137 Encapsulated Sources, C. B. Braestrup.
Subcommittee 10. Regulation of Radiation Exposure, L. S. Taylor, Acting.

There are many possible methods for disposing of unwanted radioactive wastes. It is the purpose of this Handbook to bring to the attention of those concerned, the many different factors that should be taken into account when radioactive wastes are to be dumped into the ocean, and to make recommendations for the proper use of this disposal method. The recommendations contained in this Handbook represent what are believed to be the best available opinions on the subject as of this date, but recommendations made now and in the future must be reviewed from time to time in the light of new knowledge and experience. Comments on the recommendations here presented will be welcomed by the committee.

The present Handbook was prepared by the Subcommittee on Waste Disposal and Decontamination. Its membership is as follows:

J. H. JENSEN, Chairman.
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A. V. ASTIN, *Director.*

1. Introduction and Summary of Recommendations

1.1. Introduction

The ever-increasing production and use of radioactive isotopes has raised numerous questions concerning their handling, transportation, and ultimate disposal. It appears that the sea may be an appropriate place for the disposal of intermediate and large amounts of isotopes having long half-lives (more than 1 year) or high radiotoxicity. It is the purpose of this Handbook to outline some of the factors that must be considered in the disposal in the ocean of unwanted radioactive wastes.

Two factors will generally be involved in any decision as to the method of disposal employed—safety and convenience. In many instances where the quantities are small or the half-lives relatively short, unwanted isotopes or contaminated equipment and materials may be safely disposed of by storage, flushing into the sewage or drain systems, incineration, or by burial on land.[1] [2] The choice between sea disposal and other methods will in part be determined by the quantity of the radioactive material, its half-life, and its type; but in many instances the selection may be based upon convenience and economics. It seems very reasonable to assume that producers or users of radioactive isotopes located on or

[1] Some phases of these various methods are discussed in previous reports of this Committee. See National Bureau of Standards Handbook 42, Safe handling of radioactive isotopes; NBS Handbook 48, Control and removal of radioactive contamination in laboratories; NBS Handbook 49, Recommendations for waste disposal of phosphorus-32 and iodine-131 for medical users; and NBS Handbook 53, Recommendations for the disposal of carbon-14 wastes.

[2] This is not to imply that disposal by burial in soil should be limited to small quantities and short half-lives. Land storage of solids by direct burial or in vaults, and of residues from liquid wastes in underground tanks, may be safe in specific areas. There will be a report on this subject by the National Committee on Radiation Protection in the near future.

near the coasts, or on inland waterways, may find it simpler to dispose of virtually all wastes at sea; whereas agencies that are isolated from the ocean or have only small amounts of wastes may prefer to use land burial or other methods of disposal.

This Handbook presents recommendations concerning the sea disposal of radioactive wastes that have been enclosed in massive containers. Formulation of these recommendations required a careful consideration of both immediate and long-term effects that could result from the introduction of radioactive materials into the ocean. These effects could only be estimated from an understanding of some of the basic characteristics of the oceans. The following material, upon which the recommendations for packaged waste disposal are based, is therefore necessary for an understanding of the acceptable procedures and will be helpful in dealing with specific waste-disposal problems and in evaluating other proposed methods of disposal. The problems raised are in many ways unique, and they brought to light the lack of knowledge that exists concerning many of the factors that will be involved in the ultimate distribution and fate of radioactive isotopes dumped in the ocean. Much research on the basic factors, as well as engineering investigations of specific methods of disposal, remains to be done to provide the proper guidance in this problem that is of ever-increasing local, national, and international concern.

1.2. Summary of Recommendations

a. Site

Disposal of all packaged wastes shall be in regions where water depths exceed 1,000 fathoms. The disposal of bulk wastes shall also be confined to regions where water depths exceed 1,000 fathoms, except for small quantities of liquid waste or as experimental studies indicate conditions under which disposal of liquid wastes may be safely conducted in other areas. Within these limitations, designation of specific sites does not appear necessary at the present time.

b. Transportation

All personnel handling or transporting radioactive wastes should follow recommendations given in National Bureau of Standards Handbook 42 to hold exposure to a minimum. The whole-body exposure to gamma radiation shall not ex-

ceed 300 mr/week measured in air, and exposure of the hands shall not exceed 1,500 mr/week measured in the skin.

Although recommendations cannot be made about the type of vessel to be used for sea disposal, present experience indicates that a hopper-type vessel, such as a garbage scow, may be the most suitable.

c. Regulations

There exists no authority at the present time for the control of dumping of radioactive wastes on the high seas. Packaging and handling of radioactive materials for transportation shall conform to regulations of the U. S. Interstate Commerce Commission and of the U. S. Coast Guard, wherever applicable. Regulations of the U. S. Atomic Energy Commission, the U. S. Interstate Commerce Commission, and the U. S. Coast Guard require specification labeling of packages containing radioactive materials.

d. Methods of Disposal—Packaged

Disposal of all packaged wastes shall be in regions where water depths exceed 1,000 fathoms. Containers for packaged disposal shall be designed, constructed, and filled in such a way as to insure that the package:

(a) cannot be easily damaged or broken, and will reach the bottom without appreciable loss of contents;

(b) is free of voids;

(c) has a minimum average density of 1.2 g/cm^3, or 10 lb/gal;

(d) has sufficient shielding for safe storage, shipment, and handling, and

(e) is of a size and shape to be handled quickly and conveniently.

It is recommended that packages have an identification semipermanently impressed in a concrete or metal surface; including the name of the organization preparing the package, the date, and (for use in case of accident) indication of the most hazardous radioisotope involved and of the level of activity contained.

e. Methods of Disposal—Bulk

Bulk disposal includes all operations in which radioactive wastes are discharged directly into the sea in unpackaged form. It is preferable that the material be in such a form that it will sink when discharged. For example, the ma-

terial could be prepared in the form of insoluble beads, pellets, or briquettes; or it may form a precipitate of high density. Liquid materials should have a density greater than 1.1 g/cm^2 to facilitate mixing. Greasy or oily materials that would float or coagulate and form a scum are unsuitable for bulk disposal.

Except for small quantities or experimental operations, bulk disposal shall be confined to areas in which the depth is 1,000 fathoms or greater.

f. Methods of Disposal—Pipeline

The disposal of radioactive wastes through pipelines is considered undesirable.

g. Records

Adequate records of dumping operations shall be kept. Such information, listing amounts and types of different radioisotopes, methods of disposal, localities, and dates, shall be available to the U. S. Coast Guard or to other cognizant agencies upon request.

2. General Considerations

In formulating the principles involved in radioactive-waste disposal, one immediately encounters items that cannot be evaluated numerically. Statements of maximum clarity concerning these intangibles are essential if the proposals to be made are to be understandable. Before describing the factors that affect methods of sea disposal, it is necessary to explain briefly some of the basic premises that are involved.

2.1. Public Relations Aspect

Any recommendations concerning the disposal of radioactive wastes in the ocean shall not only provide adequate safety but also be such that they will minimize (or if possible, eliminate) the possibilities of undue public alarm. Unfavorable situations might arise if a package of radioactive material were found on the shore or recovered in a fisherman's net or by a trawler or dragger. In addition to such material evidence of poor practices, there is every reason to anticipate that any decline in the sportsmen's catch, or in a commercial fishery, might be attributed to the dumping of radioactive wastes. Unsound rumors that ma-

rine food products contain sufficient quantities of radioisotopes to be detrimental to health should be countered rapidly and effectively. Last but not least, it is possible that waste-disposal practices may be responsible for international incidents leading to formal protests being lodged between nations. Advance publicity might help avoid unfavorable public reactions, and it is obvious that any recommendations should be entirely justifiable in the light of existing knowledge.

2.2. Finality of Disposal

It is of the utmost importance to remember that radioactive isotopes introduced into the ocean in ways considered desirable for waste disposal can never be removed or recovered. This point is stressed because it represents a major distinction from land burial. Because any land burial site can be either intentionally or accidentally reopened, the material is capable of recovery. There are already cases on record where for one reason or another land disposal sites have had to be shifted. In the case of sea disposal, as discussed here, the act is final. There are two aspects of this situation that should be recognized: first, sea disposal should be used only for materials for which there is no foreseeable future use; and second, if disposal at sea is carried on under conditions or to an extent that later appears to have been ill-advised or dangerous, there is no way of correcting the situation. If for any reason it becomes desirable to deposit materials on the sea floor for future recovery, appropriate methods, beyond the scope of this report, will need to be developed.

2.3. Accidental Hazards

In the laboratory, in the factory, and on land burial sites, hazards involved in radioactive wastes can be minimized or eliminated by posting notices, by erecting barriers, or by actually policing the areas. None of these can be done at sea except under extreme situations such as the tests at Bikini and at Eniwetok. In all planning for sea disposal every possible precaution must be taken to avoid hazards to individuals through accidental and unknowing contact with potentially dangerous amounts of the isotopes. The situation is analogous to "fire prevention" rather than "fire fighting." Procedures should be such that the accessible portions

of the ocean are not altered to any appreciable extent. Then in this case warnings and policing are quite unnecessary.

2.4. Rate of Disposal

Waste isotopes with long half-lives (more than 1 year) are those that are most likely to be introduced into the ocean. At the present time the potential amounts are small, but in the foreseeable future these may have to be disposed of at a high rate. It is not possible at this time to set "maximum permissible concentrations" for sea water similar to those for potable water. If the rate of supply is greater than the rate of decay, the total amount of activity in the sea will increase. It must be recognized that this will in theory set a limit on the rate at which material can be introduced into the ocean. In practice, this may prove no limit at all because of the immense volume of the ocean waters. On the other hand, we cannot assume that the materials introduced will be uniformly distributed through the entire volume. Nothing is known of how long it would take for material introduced at any locality to be more or less uniformly distributed throughout a large portion of the ocean waters, but it is undoubtedly measured in thousands of years. Therefore, there will be a practical limit to how much can be introduced at a single location or dumping ground.

The "maximum permissible concentrations" of radioactive isotopes in sea water will differ from those in drinking water. The greatest hazard will probably arise through the accumulation of radioactive isotopes in organisms that are later consumed as human food.

2.5. General Responsibilities

Any proposals for sea disposal of radioactive wastes should cover the entire problem of packaging, transportation, temporary storage, and methods and locations of discharge into the ocean. Proper safety regulations already in effect govern certain of these procedures but by no means all of them. There may be certain legal questions concerning sea disposal of radioactive wastes that must be resolved. At the present time there is no established authority to regulate matters of possible interest such as disposal areas, maximum limits, and records. The principles set forth in this Handbook are, therefore, not within any framework of recognized regulations.

3. Characteristics of the Ocean

Although the oceans are bodies of tremendous volumes, an appreciation of the broad problems involved in the disposal of radioactive wastes in the oceans should take into account not only the volumes concerned but also other physical, chemical, and biological characteristics. It is hoped that a brief outline of certain aspects of oceanography, largely extracted from "The Oceans" [1],[3] may prove helpful as a background in rendering judgment on this problem.

3.1. Volume of Ocean Waters

All oceans	1.37×10^{9} km^3, or 3.27×10^{8} mi^3
Atlantic Ocean	0.35
Indian Ocean	.29
Pacific Ocean	.72

3.2. Relief of the Ocean Basins

Continental land masses are surrounded by a *continental shelf* that is characterized by a very small seaward slope. The continental shelf may extend seaward to depths of 200 m (100 fathoms) or more beyond which there is a much steeper slope extending down into the deep ocean basins with depths of about 4,000 m or more. The average width of the continental shelf over the earth is about 30 miles, it varies from virtually zero off certain mountainous coasts to several hundred miles off coasts with extensive coastal plains. In general, the shelf is wider off the east coast of the United States than it is off the west coast.

The shelf is not smooth but is characterized by minor terraces, hummocks, and depressions. In certain areas submarine valleys and canyons cut into the shelf. The ocean basins contain features of relief as large as those found on land. Depths exceeding 6,000 m are limited to deep trenches paralleling coastal mountain chains and island arcs like the Aleutian Islands. Certain portions of the ocean are partially isolated by submarine ridges that greatly restrict the exchange of water with the adjacent deep ocean. The Black Sea and Mediterranean Sea are the classical examples. Partially isolated basins in the sea floor exist off Southern California. The Black Sea and certain fjords in Scandinavia and along the coast of British Columbia and Alaska

[3] Figures in brackets indicate the literature references at the end of this report.

are stagnant; that is, all dissolved oxygen has been utilized at subsurface levels and the deeper waters contain hydrogen sulfide.

3.3. Chemical Composition of Sea Water

Sea water is an aqueous solution of a variety of dissolved solids and gases containing small amounts of suspended material of organic and inorganic origin. It has been found that regardless of the absolute concentration of the dissolved solids, the ratios between the more abundant substances are virtually constant. The concentration of the dissolved solids is generally expressed as the *salinity*, a value slightly less than the total dissolved solids present. Units used are parts per thousand by weight (‰). For most ocean waters the salinity is between 33 and 37‰. Lower values occur in coastal areas and in and near river mouths; higher values are found in areas of excessive evaporation, such as the Red Sea. Vertical variations in salinity are usually small. In the open ocean in midlatitudes the salinity first decreases with depth and then increases slightly in the deeper water. The relative quantities of the major dissolved constituents are shown in table 1.

TABLE 1. *Major constituents of sea water*

The quantities given in this table are for a salinity of 34.325‰ and can be taken as representative of ocean water. It will be noted that they make up 99.9 percent of the dissolved solids.

Ion	‰ (parts per thousand)	Percentage of total dissolved solids
Anions:		
Chloride	18.98	55.04
Sulphate	2.65	7.68
Bicarbonate	0.140	0.41
Bromide	.065	.19
Fluoride	.0013	.00
Boric acid	.0260	.07
Cations:		
Sodium	10.56	30.61
Magnesium	1.27	3.69
Calcium	0.40	1.16
Potassium	.38	1.10
Strontium	.013	0.04
Total	----------	99.9

There are 44 elements listed in table 2, to which may be added the dissolved gases nitrogen, oxygen, neon, helium, and argon. It will be noted that a range in values is given for

a number of elements present in small quantities, notably silicon, nitrogen (in compounds), phosphorus, arsenic, iron, manganese, and copper. These are substances essential to plant life that under certain instances are reduced to zero. Too much significance should not be attached to many of the individual values, as in many cases they are little better than estimates.

TABLE 2. *Elements present in solution in sea water with a salinity of 34.325°/₀₀ (omitting dissolved gases)*

Element	Quantity (in milligrams) of element in 1 kg of sea water	Element	Quantity (in milligrams) of element in 1 kg of sea water
	ppm [a]		*ppm* [a]
Chlorine	18,980	Copper	0.001 to 0.01
Sodium	10,561	Zinc	.005
Magnesium	1,272	Lead	.004
Sulfur	884	Selenium	.004
Calcium	400	Cesium	.002
Potassium	380	Uranium	<.0015
Bromine	65	Molybdenum	.0005
Carbon	28	Thorium	.0005
Strontium	[b]13	Cerium	.0004
Boron	4.6	Silver	.0003
Silicon	0.02 to 4.0	Vanadium	.0003
Fluorine	1.4	Lanthanum	.0003
Nitrogen (compound)	0.01 to 0.7	Yttrium	.0003
Aluminum	.5	Nickel	.0001
Rubidium	.2	Scandium	.00004
Lithium	.1	Mercury	.00003
Phosphorus	0.001 to 0.10	Gold	.000006
Barium	.05	Radium	0.2 to 3×10^{-10}
Iodine	.05	Cadmium	Trace
Arsenic	0.01 to 0.02	Chromium	Trace
Iron	0.002 to 0.02	Cobalt	Trace
Manganese	0.001 to 0.01	Tin	Trace

[a] Parts per million.
[b] Recent analyses indicate that this value should be reduced to about two-thirds of the content reported. (This table is taken from "The Oceans" [1].)

The values in table 2 can be used to estimate the total amount in metric tons of any element in the ocean by multiplying by the factor 1.42×10^{12}. Values in terms of grams per cubic kilometer can be obtained by use of the factor 10^9. For example, from the higher value shown for radium, it may be estimated that the ocean contains $3\times10^{-10}\times1.42\times10^{12}=4.2\times10^2$ metric tons; or to put it in more familiar terms, 420 million curies.

Sea water is normally slightly alkaline. In contact with the atmosphere the pH varies between 8.1 and 8.3. In water in which virtually all the dissolved oxygen has been con-

verted to carbon dioxide in respiration, the pH will be about 7.5.

Dilution by river water and the freezing and thawing of sea ice *tend* to alter the relative composition, but the effects are very slight. As a working hypothesis, it is generally safe to assume that the material introduced by the rivers is balanced by biological or chemical deposition on the sea floor. This appears to be reasonable for calcium, silicon, phosphorus, manganese, iron, and several others. From the estimated rate of deposition of deep-sea sediments, some idea can be gained of rates of removal of certain elements.

3.4. Physical Properties of Sea Water

Physical properties of sea water, with the exception of transparency and color, are functions of temperature, salinity, and pressure. Temperatures range from about −2° C the initial freezing point) to about 30° C. With few exceptions the highest temperatures occur at the surface or in a homogeneous surface mixed layer that may be as much as several hundred meters thick. Below this the temperature decreases to about 5° C at 1,000 m, and to about 1° or 2° C at the greater depths. In deep ocean basins the adiabatic heating is sufficient to produce slight increases in temperature with depth. In high latitudes temperatures will be within a degree or two of 0° C from top to bottom.

Hydrostatic pressures in the sea increase approximately 1 atm for each 10 m in depth. At 2,000 m the pressure will be about 200 atm, or 3,000 lb/in^2.

The density of sea water decreases with increasing temperature but increases with increasing salinity and pressure. The normal range of the density *in situ* in the ocean is between about 1.02 and 1.06. Except in dilute sea water, the temperature of maximum density is lower than the freezing point. Hence the density increases until the freezing point is reached at about −2° C. As soon as ice forms, the "brine" of slightly higher salinity sinks to the sea bottom.

In general, the other physical properties of sea water do not differ materially from those for fresh water except for such characteristics as the electrical conductivity.

Many of the processes in the sea depend upon the vertical distribution of density. The generalized picture is that the deep ocean basins are filled with waters of relatively high density produced in high latitudes. "Floating" on this is the warm low-density surface-layer of the lower and middle

latitudes. Beneath the surface mixed layer, is a zone of density increase that tends to inhibit vertical mixing and overturn. The large effect of temperature on density is such that a first approximation of the change of density with depth can be assumed to be the mirror image of the temperature distribution.

3.5. Currents and Mixing

Currents in the sea are generated and maintained by differential heating and cooling and by energy imparted by the winds. Such water movements are relatively shallow, usually less than a few hundred meters, and speeds rarely exceed 0.5 to 1.0 m/sec (1 to 2 knots). Only in the Gulf Stream, Kuroshio, and other isolated instances do speeds reach 2.5 m/sec (5 knots). In the deep basins the magnitudes of the currents are not known, but are believed to be of the order of a few centimeters per second (a fraction of a mile a day). In addition to the major current movements, tidal currents and other periodic oscillations will contribute to the local motion. Because this motion is turbulent, it tremendously increases the rates of mixing in the sea. The existence of density layers, however, interferes with vertical mixing, so that materials tend to be spread laterally rather than vertically.

3.6. Biology of the Oceans

Plant growth in the sea is limited to the surface layers where there is adequate illumination. The thickness of this layer rarely exceeds 75 m. It will be less in turbid coastal waters and will be reduced to zero in high latitudes during the winter season. Plants growing within this layer remove CO_2 and the other substances essential for plant growth. With the exception of a few higher plants inhabiting shallow water, only algae and dinoflagellates occur in the sea. Large fixed algae are abundant in coastal areas in depths with adequate light, but for the oceans as a whole the microscopic diatoms and dinoflagellates are the great food producers. The photosynthesis in the surface layers must provide the primary food source of all animal life in the sea. Animals are present at all depths but are most abundant in the upper several hundred meters and on the sea bottom. The attraction of gravity on dead organisms and on fecal material is such that there tends to be a general removal of the essential elements from the surface layers. Most of the

detrital material is ultimately mineralized and returned to solution by bacterial action, but the *net* effect is for this to occur at depths below the photosynthetic layer. Regional plant production will be large where there are processes that by one means or another bring fertilizer-rich water back to the surface. The principal agencies that do this are winter overturn in high latitudes, upwelling along certain continental coasts (California, Peru, and the West Coast of South Africa), and violent turbulent mixing associated with strong tidal currents in shallow water. In such areas the plant production is probably of the same magnitude as that obtained on fertile land. On the other hand, in the open ocean in middle and lower latitudes where the plant foods are depleted, there are "desert" conditions.

No significant quantities of marine plants are used for human consumption. The exceptions are certain of the larger algae that are used as vegetables and also as cattle feed, and others that are sources of commercial products such as agar, and the group of alginate products made from kelp. *Animals taken for human food include mammals, fish, crustaceans (crabs, lobsters, shrimp), mollusks, and a few representatives of other groups.* In discussions of productivity, it is necessary to consider *food chains*. For example, oysters may feed directly upon the diatoms and dinoflagellates. On the other hand, high predators, such as the tunas, may feed on smaller fish, that in turn have eaten other fish that depended upon small arthropods that were the original grazers feeding on plant life. Virtually nothing is known of the efficiency of tissue formation at each step in the food chain but it is estimated that it is about 10 percent. In other words, there is a decrease by an order of magnitude in the living organic matter at each step in a food chain.

The microscopic plant life is referred to collectively as phytoplankton; the small floating animals that feed upon it and upon each other, as zooplankton. During the daylight the zooplankton tends to remain below the lighted photosynthetic layer, rising at sunset to feed during the night, and returning to deeper water at sunrise. This mechanism contributes to the net removal of materials from the surface layers. Zooplankton and some fish (such as the herring) are filter feeders and gather in the particulate food indiscriminately. The same method of feeding is apparently true for many of the bottom-living marine invertebrates such as mussels, clams, barnacles, etc. The larger and more active

forms are apparently more selective. Certain forms of fish and some invertebrates, such as crabs, are scavangers, eating any organic material that comes their way. Some are mud eaters, depending upon the detrital material in the sediment for their supply of organic matter.

Various indirect methods have been used to estimate rates of production and total annual production of plants in various localities. Daily rates range between 0.01 and 1.0 g of carbon per cubic meter with an average of about 0.15. Estimates of annual production on a areal basis range between about 10 and 1,000 g of carbon per square meter per year. If it is assumed that photosynthesis is limited to a layer 50 m thick, these values become 0.2 and 20 g/m^3/year. Plant production in most regions is limited by the depletion of the fertilizers, phosphate and nitrate. It is possible to determine concentration factors for the elements that are present in the sea in small amounts. For example, carbon appears to be concentrated in marine organisms by a factor of about 10^3, nitrogen and phosphorus by factors of 10^5 or 10^6, iron and copper by a factor of 10^3. As stated earlier, the microscopic plants are apparently able to remove substances such as phosphate and nitrate almost completely.

Rates of growth are almost unknown. Phytoplankton increase by binary fission, roughly once a day, and consequently under favorable conditions will accumulate at tremendous rates. Zooplankton forms probably go through several life cycles in a year. Fish of commercial importance have life spans of at least several years.

Some mention has been made of the daily vertical migrations of the zooplankton. The same apparently applies to many species of fish and mammals. On the other hand, many bottom-living forms such as halibut, flounder, etc., may spend their entire adult lives on the bottom. There is a tremendous range in the extent of the horizontal migrations. Certain forms such as eels and tuna travel thousands of miles, whereas others spend their entire lives within a limited area. Migrations are, however, the rule rather than the exception. It is only some invertebrates such as oysters and clams that remain in one place after settling of the larvae. Fish and other forms used for human food are most abundant in the upper few hundred meters and they are especially abundant on the continental shelf. For economic reasons, extensive fisheries tend to be on or near the continental shelf in proximity to centers of large populations.

The animal population on the deep ocean floor is very sparse in comparison to shallow bottoms. *There is no commercial fishery of the deep sea bottom and no significant migration of bottom-living forms between the deep and shallow waters.*

3.7. Marine Sediments

The marine sediments in shallow water do not differ materially in composition or texture from those of the adjacent beaches and coasts. On the continental shelf the sediments are sandy or silty except in depressions and off river mouths where soft muds will be formed. In the deep ocean basins the sediments are typically fine-grained clays with variable amounts of skeletal remains of planktonic plants and animals. These may be siliceous (diatoms and radiolarians) or calcareous (coccolithophores, foraminifera, and pteropods). The proportion of siliceous remains in the sediments is rarely very high. Certain calcareous sediments contain virtually no materials other than calcium carbonate. Sediments in depressions are soft and fine-grained; those on elevations, regardless of depth, are hard and coarse-grained; or may be lacking, so that the rocky surfaces of the elevations are exposed. In shallow water the calcareous remains of certain algae and animals will accumulate in the sediments. In warm tropical waters, so-called coral reefs and islands may contain nothing except the remains of corals and calcareous algae. Deep sea sediments are, therefore, made up of fine-grained material of terrigenous origin (red clay), volcanic debris, skeletal remains derived from dissolved material, and some decomposable organic detritus. The accumulation of organic detritus implies the removal from the water of certain of the plant fertilizers. In addition there are elements that by some means apparently accumulate on the sea floor; these include manganese, iron, phosphorus, and radium. Whether or not biological processes are involved in these cases, and in others, is not definitely known.

Rates of sedimentation for the deep-sea deposits have been estimated to be of the order of 1 cm per 1,000 years, being less for red clay and slightly more for the calcareous deposits. Rates of deposition off rivers will be large but, except in particular areas, the accumulation on the shelf is very small. On the continental slopes, rates of accumulation are probably of the order of tens of centimeters per 1,000 years.

Most of the organic detritus reaching the sea floor is undoubtedly broken down by bottom-living animals and bacteria. Where the supply is relatively abundant, burrowing animals undoubtedly overturn the sediments in the same way as earthworms do on land. However, in the deep ocean basins the sediments do not indicate any such overturn. The interstitial water does not differ materially from that in the water column above except in regions where, because of relatively high rates of supply of organic debris and low rates of supply of oxygenated water, stagnation develops and only anaerobic bacteria can survive. Such conditions exist in the Black Sea and certain fjords. In other coastal regions the sediments may be stagnant although the overlying water column is not.

The foregoing information indicates the mechanisms whereby materials introduced by rivers are removed from the water column, so that for many purposes it is reasonable to assume that a condition of dynamic equilibrium exists in the ocean. This, however, will not be true when we consider smaller areas or short time intervals. River water on entering the sea forms a "puddle" because of its lower density. This layer spreads and gradually mixes with the sea water, primarily because of turbulence created by wind waves and tidal currents. Solid particles tend to flocculate and settle, and certain chemical precipitation may occur for such elements as iron and manganese. It is estimated that each year rivers introduce 2.7×10^9 metric tons of dissolved solids and comparable amounts of particulate sedimentary material.

3.8. Pollution

Activities of man contribute to the supply of materials to the sea and sometimes affect the biologic balance. Locally, these effects are sometimes sufficient to cause unfavorable changes in the natural environment. As a result, fish and other forms taken by sportsmen and commercial fishermen may decrease in abundance or disappear entirely; or an area may be rendered unattractive for human use and recreation. Such effects are usually called pollution. In other cases, dumping of unwanted materials into the sea has no apparent detrimental effect, and consequently few or no objections are raised. To date, two types of pollution seem to be the cause of the greatest trouble. These arise from (a) the discharge of large quantities of organic debris, such as domestic sewage and industrial effluents from the food and beverage

industries, and (b) the discharge of large quantities of industrial effluents that contain toxic chemicals. Whenever there are large local supplies of organic debris there is an increased probability of oxygen depletion, which will then kill all higher forms of life. Chemical wastes can be toxic directly to the fish or to some lower form involved in the food chain. To avoid undesirable pollution, submarine pipelines are sometimes extended as far as a mile off shore, sites of discharge are selected so as to be in regions of strong currents and active mixing, or in extreme cases the material is taken out to sea by barge and released in such a way as to minimize undesirable effects. In many instances pollution reaches damaging proportions before any remedies are sought or controls are established. Although recovery from damage due to organic pollution is fairly rapid, effective recovery for long-lived radioactive pollution may require long periods of time.

The altered and narrowed fauna in industrial harbors compared to previous rich growth shows the results of cumulated pollution. *Control of dumping of domestic and industrial wastes is a matter of concern to Federal, State, and local agencies concerned with fisheries, public health, and recreation.* Because of their responsibilities for navigable rivers and harbors, the Army Engineers have certain regulatory powers. Enforcement of regulations is in the hands of the local authorities and the U. S. Coast Guard. The authority of all such agencies usually ends at the 3-mile territorial limit. *Unless it is in any way a danger to shipping, anything can be dumped anywhere on the high seas. The only United States control over such practices is the authority of the U. S. Coast Guard to control the types and quantities of dangerous substances that can be carried aboard U. S. vessels.* The claims made in recent years to the national interests in the resources of the continental shelves indicate that in the foreseeable future regulatory control may be extended beyond the present 3-mile limit (or greater distances off certain foreign countries). At the present time, there are no regulations for disposal of radioactive wastes on the high seas. For such regulations to be fully effective, they should be by international agreement.

The introduction of radioactive wastes into the ocean is an entirely new practice and unless conducted properly can result in new kinds of pollution in the sense given above. As mentioned, protests against waste disposal arise because

of catastrophic or cumulative effects on sea life, spoilage of the shoreline, or creation of obvious public-health hazards. The indiscriminate dumping of radioactive wastes could lead to a far more insidious type of pollution, primarily because of the absence of immediate effects that would arouse public indignation. *The onus therefore rests upon agencies responsible for radioactive-waste disposal to see that such practices never will constitute a pollution hazard.*

4. Fate of Radioactive Materials Introduced into the Ocean

4.1. Factors Favoring Dilution or Dispersal

Two primary factors should be considered in the disposal of wastes in such a way as to minimize or eliminate hazards. These are dilution (or dispersal) and isolation. Disposal in deep water far from land takes advantage of both factors. If the materials are in such a form that they will come to rest on the sea floor or actually penetrate the soft sediments, they can be considered as removed from all foreseeable opportunities for human hazard, either through direct contact or indirectly through raw materials or marine animals used as food.

Among the natural characteristics that will reduce or eliminate hazards from radioactive wastes are:

(a) *Natural decay:* The degree of reduction of hazards will depend upon the individual isotope.

(b) *Isotopic dilution:* Reference to table 2 will indicate whether or not the naturally occurring element is present in solution in sufficient abundance to reduce the hazards that might arise from the accumulation of the radioactive isotope by plants and animals.

(c) *Dilution:* The mixing of the water will rapidly reduce local concentrations and, except on the continental shelf, the net effects of current movements and mixing will tend toward horizontal spreading. Initial dilution or dispersal at the time of disposal will, of course, favor this process.

At this time it is necessary to examine some of the hazards that may arise from sea disposal of radioactive wastes.

4.2. Direct Hazards

To minimize or eliminate hazards from packaged wastes, containers must be of such a nature that they sink to the

bottom, remain intact until they reach the bottom, and are not dumped in any region where they might be accidently or intentionally retrieved during fishing or salvage operations. Bulk wastes shall be discharged in such a way that the initial concentrations are below levels that might be dangerous. Accumulations of certain isotopes might occur on nets and on ships' hulls, sanitary systems, and condenser systems. The exposure of swimmers precludes the disposal of materials near beaches used for recreation. Future large-scale desalination of sea water for irrigation or for industrial or domestic use might conceivably create hazards in the processing plants.

4.3. Indirect Hazards

Indirect hazards are those that might arise through the accumulation of radioactive isotopes by marine organisms used for human food. As described in the section on the chemistry of sea water, it is possible for a few elements to be concentrated by a factor of 10^6. This would mean that all of the element originally present in 1 m^3 of sea water is concentrated in 1 cm^3, or 1 g, of fish. The only elements known to be concentrated to this extent are phosphorus and nitrogen, and hazards from radioactive isotopes of these elements are lessened because of their short half-lives. Whether any other element is concentrated to this degree is unknown, but it would seem reasonable to assume that a factor of 10^3 might be anticipated. This would correspond to the accumulation in 1 g of tissue of the material initially present in 1 liter of water.

As an example, radium may be used. One liter of sea water contains about 1×10^{-13} g. Assuming that this is concentrated 1,000-fold, if a person ate 100 g of fish per day for 25,000 days (70 years), he would ingest a total of $10^{-13}\times100\times2.5\times10^4=2.5\times10^{-7}$ g, or 0.25 μc. This example is not intended to do more than indicate a very conservative way by which tolerable limits for radioactive isotope concentrations might be established.

The maximum permissible concentration in drinking waters for radium has been set at 4×10^{-8} $\mu c/cm^3$ [2]. This is equivalent to 4×10^{-11} g/liter, a concentration 400 times greater than that naturally occurring in sea water. If our fish supply were grown in water containing this amount of radium, the indirect hazards would be much increased. However, if it were possible to allow concentrations of radium as large as this, namely, 400 times greater than the

amount naturally present, it is easy to determine how much radium could be added to sea water to raise the content to drinking-water tolerance. A cubic kilometer contains 10^{12} liters. Therefore: radium in 1 $km^3 = 10^{-13}$ g/liter $\times 10^{12}$ liters/$km^3 = 0.1$ g. To raise the concentration to the permissible level would permit the addition of 39.9 g/km^3.

These calculations emphasize the fact that it is highly improbable that disposal of radioactive wastes at sea will ever materially affect the ocean as a whole. Local concentrations, however, might become hazardous unless precautions are taken to avoid their accumulation by marine organisms. *This emphasizes the desirability of disposal in the deep basins or at initially low concentrations.*

Studies made on the disposal of chemical wastes from barges [3] afford an estimate of the magnitude of the "immediate" dilution. While the barge was underway the wastes were discharged through the two vents located at the bottom of the barge. The cross section of the barge was about 7×5 m and it was being towed at a rate of 6 knots (300 cm/sec). The turbulent wake was therefore generated at the rate of $7 \times 5 \times 3 = 105$ m^3/sec, giving immediate dilution of 300 to 1 for wastes being discharged at about 0.3 m^3/sec. In addition the turbulent wake spreads both horizontally and downward; so it can be assumed that the immediate dilution is of the order of 1 in 1,000. This could be increased by another factor of 10 by reducing the rate of discharge. It is therefore entirely feasible to obtain immediate dilution by barge disposal of the order of magnitude of 1 part in 10,000. These generalizations assume that the waste liquid is entirely miscible with water and of equal or slightly greater density. Whether or not the isotopes remain in solution or precipitate when mixed with sea water does not appear to be a major factor as long as the disposal is made over deep water. Engineering study of the limitations of barge disposal of radioactive wastes appears to be warranted.

5. Considerations for Selection of a Disposal Method

The choice between sea disposal and other methods will depend upon the quantity and type of radioactive waste, its physical and chemical state, and upon the convenience for the agency involved. The selection of the best method of

disposal at sea will depend upon more factors than can be considered here in detail. It is, however, desirable to outline the general criteria that should be met and to indicate the various means that might be employed in radioactive-waste disposal.

The practical solution of waste-disposal problems will involve consideration of the following characteristics of the isotopes involved:

(a) Half-life,

(b) Chemical properties, and initial chemical state,

(c) Physical state (liquid, solid, occluded, or adsorbed on inert material),

(d) Biological properties (radiotoxicity, biochemistry of element), and

(e) Amount on hand and rates of supply.

The chemical properties will be important with respect to whether or not the isotope will react with the dissolved constituents in sea water. The physical state will be a determining factor in many problems and may dictate the means of disposal. The indirect hazards will depend upon the biological properties of the isotope (such as its radiotoxicity), the role it may play in the bioeconomy of the sea, and the possibilities of its accumulation in human food supplies. Finally, the selection of any acceptable method of disposal will depend upon the amounts of the isotopes involved and upon whether or not the disposal is a single event or must be planned for repeated operations. These items will usually be known or can be estimated with reasonable accuracy.

Consideration of the criteria that must be met in sea disposal is complicated by our lack of knowledge of many of the factors involved, so that they can be stated only in general terms. The most important criteria are that methods of radioactive-waste disposal should (a) avoid foreseeable direct hazards, (b) avoid foreseeable indirect hazards, and (c) avoid undesirable long-term consequences.

Direct hazards, by definition, are those that might arise from exposure to dangerous levels of radiation (see section 4.2). Therefore the waste material should be *isolated*, to avoid the possibility of close proximity, or should be *diluted* to a level that is completely safe. Effective isolation can best be achieved by disposing of the material in the deep ocean far from land. Virtually complete isolation can be achieved by depositing the material on or in the sediments

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of the deep ocean floor. Obviously, isolation is the prime consideration for large amounts of isotopes, insoluble materials, contaminated equipment, apparatus, etc. This will also be true of packaged materials *in any amounts*, for it is most undesirable to permit the package and its contents (or whatever type) to be recovered. Dilution is the obvious method of disposing of small quantities of isotopes, particularly those of short half-life and those in solution. The problem becomes more complicated when the amounts are large.

Indirect hazards, by definition, are those that might arise from the accumulation of potentially harmful amounts of radioactive isotopes in marine organisms used for human food (see section 4.3). To avoid such hazards the objective should be to dispose of waste materials in such locations that the likelihood of their reappearing in food is minimized. This again involves the principles of isolation or dilution of the material. However, the concentrations permissible in the water are minute compared to those that represent direct hazards; and as described in section 4.2, it is the processes of biological accumulation that will establish the permissible concentration of isotopes in the ocean waters. Packaged waste deposited on the bottom of the deep sea does not contribute any foreseeable indirect hazard, because there is no significant biological exchange between the deep sea and the surface layers and because there is no fishing at depths of 1,000 fathoms and more. Bulk disposal, which is made at or near the sea surface, does not satisfy the criterion either of isolation or of immediate dilution to negligible activity levels. However, practical consideration of the problem shows that the quantities to be disposed of, the types of material, etc., will be important factors in deciding whether or not bulk disposal is allowable. In all cases depth of water and distance from shore, as well as major fishing areas and shipping lanes, should be considered.

Undesirable long-term consequences are those that might arise because of the slow accumulation of long-lived radioactive isotopes in the ocean. If the rates of disposal exceed the rates of decay it is obvious that the amounts present will increase. If the materials form insoluble precipitates, or were originally insoluble, they will accumulate on the sea floor; and as long as this is in deep water they are not hazardous. If, however, the materials are soluble or were in solution, processes of mixing and the ocean currents will

ultimately bring them near the sea surface and into coastal areas where biological processes may concentrate them. Because of the tremendous volume of the ocean waters, it appears at the present time, that this is a negligible hazard. *In reviewing long-term consequences of radioactive-waste disposal, it should be remembered that the half-lives of many of the isotopes are long, compared to the probable life of the container.* Furthermore, any damage to the container will accelerate the escape of the contents. Any assumption concerning long-term effects of wastes in the sea should consider that the container merely delays the diffusion of the material through the water mass. A further step toward retarding such accumulations in the water would be actually to bury the container in the sediments. The natural rate of sedimentation in the deep ocean basins is inadequate. However, if topographic elevations are avoided, the sediments are sufficiently soft that a dense container dropped from the sea surface would sink to depths of several feet into the ooze. Here it is in effect completely isolated unless heat generated by the contents is sufficient to produce convective flow in the surrounding sediments. Even if the container disintegrated, there would be limited opportunity for the escape of the contents into the water.

It is conceivable that the disposal of radioactive wastes into the ocean might someday attain such proportions that it would become necessary thenceforth to limit disposal to rates not greater than the rates of decay of the accumulated wastes.

6. Means of Disposal

For convenience, it is possible to consider all methods of sea disposal under three general types: Package disposal, bulk disposal at sea, and pipeline disposal.

6.1. Packaged Disposal

The problems of recommendations concerning packaged disposal have already been presented in this Handbook and will not be considered any further.

6.2. Bulk Disposal at Sea

Bulk disposal includes all operations in which radioactive wastes are discharged directly into the sea in unpackaged form. The tanks, barges, or other means used for transportation are, in effect, reclaimable containers. Bulk dis-

posal has many advantages where the wastes are of large volume but relatively low radiation intensity.

In bulk disposal, it seems reasonable to assume that safety measures governing the transportation and handling of the material will set practical limits on radiation levels from the material after discharge. A primary consideration is to minimize the possibilities of the waste being concentrated by marine organisms and ultimately appearing in foods. This can be achieved by dumping the material far away from centers of population and of fishing activity and in the deep ocean where the abundance of plankton is small. It is preferable that the material be in such a form that it will sink when discharged into the sea. This could be achieved by preparing the material in the form of dense briquettes, pellets, or beads by mixing the isotopes with inert insoluble materials that could, if necessary, be of resistant ceramic or concrete. Such solid objects would sink rapidly and hence the material would be quickly carried to an inaccessible location. This procedure possesses a number of advantages if the quantities are large, and if the chemical and physical characteristics of the radioactive wastes lend themselves to such handling. The pelleted material can be handled in bulk and transported and discharged at sea with the same convenience as liquids; and it has the further advantage that it can be prepared in characteristic shapes or colors for easy identification and recovery if accidentally spilled. *Such material shall be dumped only in areas where the water depths exceed 1,000 fathoms.*

Wastes in liquid form will mix with sea water while being discharged, and advantage should be taken of ways that will accelerate mixing and dilution. An example of liquid waste disposal from a barge is described in section 4.3. To facilitate mixing, the wastes should be in a water solution having a density greater than that of sea water. Greasy or oily materials that would tend to float or coagulate and form a scum are unsuitable for bulk disposal because of the possibilities of the material drifting ashore.

Experimental studies may indicate conditions under which disposal of large quantities of bulk liquid wastes may be safely conducted in certain areas of depths less than 1,000 fathoms. Until such studies are made, except for small quantities, liquid wastes shall not be released in waters of depths less than 1,000 fathoms, except under experimental conditions.

6.3. Pipeline Disposal

One of the traditional methods of disposing of unwanted wastes is by means of pipelines entering the sea. Such means are used for domestic sewage and by many industrial plants. The very undesirable pollution resulting from such practices can be observed near any coastal community. To reduce the possibilities of such pollution, installations of longer pipelines have been made in order to have the outfall in deeper water and farther from shore. This reduces the concentration of material that reaches the beach because the turbulence and along-shore currents tend to disperse the material. Such systems presuppose that the effluent is of lesser density than the sea water, and will therefore rise and mix with the water over the outfall. Although submerged outfalls with discharge at a distance of a mile or more from the coast may appear to have certain advantages in ease of disposal, such systems fall far short of meeting the general requirements for safe disposal of radioactive isotopes. Disposal will usually be made near centers of population and in shallow water. The possibilities of direct hazards are great. In addition, the possibilities of indirect hazards are increased by the accumulation of isotopes that will occur in the water and sediments and therefore be available to organisms that will be used as food. For these and other reasons the disposal of radioactive wastes through pipelines is undesirable.

7. Designation or Selection of Sites of Disposal

Disposal of all packaged wastes shall be in regions where water depths exceed 1,000 fathoms. The disposal of bulk wastes shall also be confined to regions where water depths exceed 1,000 fathoms except for small quantities of liquid waste or as experimental studies indicate conditions under which disposal of liquid wastes may be safely conducted in other areas. Within these limitations, designation of specific sites does not appear necessary at the present time.

It may be stated immediately that from the public-health point of view, there is no short-term advantage to be gained from the designation of specific dumping areas for either packaged or bulk radioactive wastes. Long-term consequences, resulting from the gradual accumulation of isotopes in the water, will not be materially affected by the exact localities of disposal.

It should be recognized that the dumping of radioactive wastes will raise the normal radiation background of the water. With the development of nuclear power for the propulsion of naval vessels, including submarines, and of nuclear weapons, detection by means of radiation-measuring systems may be a matter of military concern. It is believed, that the location of disposal of radioactive wastes may be of concern to military authorities.

The U. S. Coast Guard is responsible for all U. S. shipping, other than military vessels, and this agency is charged with the enforcement of many regulations governing safety of personnel, pollution, and activities of vessels. In problems arising in the disposal of explosives and industrial wastes, it is customary to designate specific dumping areas. Selection of such sites is a problem of mutual concern to the U. S. Navy, the U. S. Coast Guard, the U. S. Public Health Service, and the U. S. Fish and Wildlife Service. If experience indicates the desirability of large-scale disposal of radioactive wastes in the ocean, these and other agencies may become interested in the question of whether or not the designation of specific dumping areas is desirable; and if so, what specific localities may be appropriate.

8. Recommended Containers for Packaged Disposal in the Ocean

8.1. General Characteristics

Containers used for packaged disposal of radioactive wastes into the ocean should be designed, constructed, and filled in such a manner as to achieve the following objectives:

(a) Structural design to insure, under conditions of shipment and handling, that the package cannot be easily damaged or broken and will reach the bottom of the ocean without appreciable loss of contents;

(b) Sufficiently high specific gravity to insure sinking to the bottom;

(c) Sufficient shielding from radiation originating within the container to prevent excessive exposure of personnel during shipment, storage, or handling; and

(d) Size, shape, and accessory features to facilitate safe, convenient, and quick handling.

8.2. Materials of Construction

The most economical materials of construction commensurate with the above objectives appear to be concrete and steel in suitable combination. Adaptations of commercial "shapes" are advantageous where appropriate. The most common example of such adaptation is the use of standard 55-gallon steel drums, which serve as external containers and forms in which the radioactive materials are embedded in concrete. The National Institutes of Health have found standard concrete burial vaults generally useful for the same purpose [4, 5].

8.3. Design of Package

Although it is not considered appropriate to specify standard packages, the following comments on current practices may be found helpful. A common method of use of steel drums is to pour several inches of concrete into the bottom, build up the content to within a few inches of the top by placing radioactive objects near the center and pouring concrete around them, and complete the package by filling to the top with concrete. In other cases the radioactive material is confined in a smaller drum concentric with the outer one and the space between them filled with concrete.

Eyes or rings for convenient handling should be cast in the concrete or fastened to the outer metal container. The degree to which reinforcing of the concrete should be used will depend upon the nature of the contents. Steel reinforcing should be designed to prevent rapid loss of contents in the event that the package is ruptured by hydrostatic pressure. In the event that the package contains objects that would normally float, reinforcing should be designed to prevent their separation from the concrete. In addition to rods, the use of heavy woven wire may be desirable.

Packages should be filled in such a manner as to be free of voids and, if possible, of considerable volumes of compressible materials. In general it is impractical to design a package containing large voids that will not be ruptured by hydrostatic pressures at depths of several thousand feet. In cases in which it is desirable to include large volumes of compressible material, it will be desirable to include appropriate means for equalization of pressure between such volumes and the exterior of the package without any loss of contents of the package from handling and transportation. For example, a small, thin-walled metal tube extending into the

compressible material from outside, and with the inner end of the tube crimped shut to prevent leakage during handling or shipment. This should be acid resistant if the material is corrosive.

8.4. Specific Gravity of Package

The maximum density of water in the ocean is estimated to be approximately 1.1 g/cm^3. It is recommended that the actual minimum density of any package prepared for disposal in the ocean should be at least 1.2 g/cm^3 or 75 lb/ft^3 or 10 lb/gal. In cases in which the determination of the volume of the package is subject to uncertainties, the design density should be increased sufficiently to insure that the actual density is never less than the above value.

8.5. Identification

Regulations of the U. S. Atomic Energy Commission, U. S. Interstate Commerce Commission, and U. S. Coast Guard require specification labeling of packages containing radioactive materials. In addition, it is suggested that persons preparing packages for disposal at sea may find it advantageous to provide a semipermanent identificaion impressed in a metal or concrete surface for use in the event that subsequently it becomes desirable to distinguish them from similar packages prepared by other persons. Such identification should include the name of organization preparing the package, the date, and (for use in case of accident) indication of the most hazardous radioisotope involved and of the level of activity contained.

9. Recommendations for the Transportation of Radioactive Materials

Packaging and handling of radioactive materials for transportation shall conform to regulations of the U. S. Interstate Commerce Commission and of the U. S. Coast Guard wherever applicable [6]. Storage of containers of such wastes before shipment should be under proper posting or in defined enclosures. In the actual handling and transfer of waste containers, any safe method is acceptable. Some commonly used procedures include hoists, fork lifts (using pallets), and similar mechanical devices.

For complete information on this subject, the shipper should refer to U. S. Interstate Commerce Commission and

U. S. Coast Guard documents in which these regulations are published. A summary of the current regulations includes the following provisions: The design and preparation of the package shall be such that there will be no significant radioactive surface contamination of any part of the container; that the gamma radiation will not exceed 200 mr/hr or equivalent at any point of readily accessible surface; and that the gamma radiation at 1 m (distant) from any point on the radioactive sources will not exceed 10 mr/hr. These regulations provide also that, except by special arrangement, the radioactive content of any single package shall not exceed 2 c of radium, polonium, or any other member of the radium series; and not more than that amount of any other radioactive substance that disintegrates at a rate greater than 10^{11} atoms/sec.

All personnel handling or transporting radioactive wastes should follow recommendations given in National Bureau of Standards Handbook 42 to hold exposure to the minimum, and maximum-permissible-exposure values recommended in that publication shall not be exceeded. The whole-body exposure to gamma radiation shall not exceed 300 mr/week measured in air, and exposure of the hands shall not exceed 1,500 mr/week measured in the skin.[4]

Although recommendations cannot be made relative to the type of vessel to be used for sea disposal, present experience indicates that a hopper-type vessel, such as a garbage scow, may be the most suitable; because (a) waste containers don't have to be lashed to the deck during their sea journey, (b) the lower center of gravity (with containers in the hold) reduces the pitch and roll of the ship, and consequently (c) the hazards of the dumping operations at sea are lessened.

10. General Responsibilities and Problems for Consideration

It is the purpose of this Handbook to bring to the attention of those concerned, the many different factors that should be taken into account when radioactive wastes are to be dumped into the ocean. In many instances, it has been impossible to give anything more than general statements. Knowledge concerning the physical processes that will distribute the wastes through the ocean waters is almost com-

[4] National Bureau of Standards Handbook 59, Permissible dose from external sources of ionizing radiation (1954).

pletely lacking. The biological processes by which isotopes may be concentrated by marine organisms are, as yet, quantitatively unknown and for this reason it is not currently possible to set maximum permissible levels for sea water. Such values should be established for the guidance of those concerned with waste-disposal practices and for those agencies that may be charged with the responsibility of supervising disposal operations or of monitoring the conditions in the ocean. Natural backgrounds are virtually unknown and these should be determined at an early date.

Procedures for the disposal of packaged wastes are reviewed in this Handbook. For the handling of bulk wastes, each case may very well be a specific problem because of differences in types and amounts of the isotopes, their physical state, levels of activity, etc. In such cases, definite regulations may not be pertinent because the operations will probably involve specially designed facilities for both land and water transportation. The U. S. Interstate Commerce Commission and U. S. Coast Guard have procedures for the approval, under special permit, of the handling of shipments that do not fully meet the detailed provisions of published regulations but are consistent with the general standards of safety maintained by these agencies.

It has been pointed out that there exists no authority for the control of dumping of radioactive wastes on the high seas. To be of any real value, ultimate authority should rest on international agreement.

In a field as new as this, it is impossible to foresee what quantities of activity discharged into the oceans will produce undesirable consequences. Such recommendations as are made now and in the future must be reviewed from time to time in the light of new knowledge and experience. For this reason, as well as for others, *adequate records of dumping operations shall be kept. Such information, listing amounts and types of different radioisotopes, methods of disposal, localities, and dates, shall be available to the U. S. Coast Guard or to other cognizant agencies upon request.* At the present time, no agency has assumed this responsibility, but it is desirable that such agency be designated.

From this Handbook, it is apparent that problems of radioactive-waste disposal are of concern to many different interests. Responsibilities for the safe handling and disposal of the wastes rest upon one or more of the following: The original producer, the user, and the agency conducting the dis-

posal operation. Regulations or recommendations concerning the methods of transportation and disposal may be issued by public health authorities, the U. S. Atomic Energy Commission, the U. S. Interstate Commerce Commission, the U. S. Coast Guard, the U. S. Public Health Service, the U. S. Army Engineers, and/or other local, State, or national agencies. Selection of sites of disposal, methods of disposal, amounts, and/or rates of disposal should ultimately be matters of international concern. The practical considerations of national advice and/or control, monitoring of levels of activity, etc., have not yet been solved but are of concern to the U. S. Public Health Service, the U. S. Coast Guard, and the U. S. Navy.

It should be stated specifically that two major aspects of radioactive contamination have been completely omitted from this report; (a) the fate of materials entering the ocean from the atmosphere, and (b) the catastrophic effects that might arise from the accidental release of large amounts of materials resulting from disasters on or near the sea or those resulting from military action. These problems are being dealt with by other agencies, but many of the items discussed in this report are applicable to them.

11. References

[1] H. U. Sverdrup, M. W. Johnson, and R. H. Fleming, The Oceans (Prentice-Hall, Inc., New York, N. Y., 1952).

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[5] G. W. Morgan, Considerations on disposal at sea, Isotopics **3**, No. 1, p. 5 (1953).

[6] U. S. Interstate Commerce Commission regulations: Title 49, Code of Federal Regulations, Parts 71 to 78. Part 73, paragraphs 73.391 to 73.396, 73.401 to 73.404, 73.414, 73.427, 73.428, 74.566, 77.823, and 77.841 contain the principal regulations of especial interest to shippers of radioactive materials. Authorized reprints of parts 71 to 78 are issued by the Bureau of Explosives of the Association of American Railroads, 30 Vesey Street, New York 7, N. Y., Agent H. A. Campbell's Tariff No. 8; and by the Tariff Bureau of the American Trucking Association, 1424 16th Street, N. W., Washington 6, D. C., Agent F. G. Freund's Tariff No. 7.

U. S. Coast Guard regulations: Title 46, Code of Federal Regulations, Part 146. Paragraphs 146.05–15, 146.05–17, 146.25–1, 146.25–20, 146.25–25 and 146.25–30 contain the regulations of especial interest to shippers. An authorized reprint of part 146 is issued by the Bureau of Explosives of the Association of American Railroads (see address above) as Agent H. A. Campbell's Tariff No. 6.

Submitted for the National Committee on Radiation Protection.

LAURISTON S. TAYLOR, *Chairman.*

Representative HOLIFIELD. At this time I will invite the various witnesses who have testified in these hearings to take chairs in a semicircle in front of the committee, and we will have one or two questions and maybe more to submit to the panel as a whole.

All witnesses that have testified before the committee are invited, if they wish to, to come forward and take these extra chairs.

Now, as each member of the panel speaks, I will ask them to identify themselves for the benefit of the reporter before propoundng their question or making a statement.

The purpose of the panel is to give an opportunity to any of the witnesses to bring up any matter which they feel has not been discussed adequately, or to make any statement which they wish to make upon any statement which has been made, and in order to get to the subject which the committee is interested in primarily, I would ask this following question:

In the opinion of the members of the panel, is the present research and development program sufficient to assure safe disposal of radioactive wastes, let us say, in the year 1980, without hazard to our society?

Anyone who wishes to respond to that may do so.

Dr. Parker, would you like to start off with a statement on this?

Mr. PARKER. Mr. Chairman, if a scientist appeared before the committee and testified that adequate funds were available in his specialty, I think this would establish some kind of record. But perhaps in the subject matter it is rather closer to this than many others.

As I see it, from the radiological sciences, additional funds could well be made available to study the ramifications of the food webbs that both Dr. Morgan and I tried to illustrate in our earlier appearances before you. And I would suggest that this be looked at as an avenue for increase of funds.

Representative HOLIFIELD. I realize funds must come after program. My question really was directed toward the point of whether a program exists, whether programs exist, in these various fields, which in your opinion are adequate. Or should those programs be increased? And, of course, that would mean an increase in funds.

Mr. PARKER. In going into the total environment of man, Mr. Chairman, I think it is well nigh impossible to define a correct limit for research programs, and I would say as a personal opinion that what we are doing now is a little bit below par for the course, but not outstandingly so.

Is that responsive to your question?

Representative HOLIFIELD. I think that is fairly responsive to the point.

Are there any comments from any of the other members of the panel on this?

I think if you make them in a loud voice, it would not be necessary to come forward to the mike.

There seems to be no comment on that particular point.

Dr. LIEBERMAN. Mr. Chairman, I am J. A. Lieberman of the Atomic Energy Commission, Reactor Development Division.

I think it might be worth while to just mention very briefly the scope of the research and development programs that we are involved in within the AEC, at least within the Reactor Development Division.

We can say that there is a fairly well developed, coordinated, and integrated program that involves the number of Federal agencies that have testified here, the Public Health Service, the Geological Survey, the Weather Bureau, a number of different universities spread all around the country, and essentially all of the AEC National Laboratories. There have been numerous technical reports and a number of meetings and sessions and conferences of one kind and another that have been devoted exclusively to this subject.

So, from the standpoint of the program itself, I think we can certainly say that there is a program that one can look at. Now, whether this program is extensive enough, or whether it is getting enough support, is perhaps an associated question.

I would agree with Dr. Parker quite enthusiastically that there is no question in my mind but what we could use more money. You gave a kind of a semideadline, the year 1980. I would say that additional projects within our program and additional funds could be utilized effectively, to come up with answers—and when I say "answers," I mean engineering answers to some of the questions that have been raised during the course of the hearings—to meet that deadline.

As I indicated in my very brief statement introductory to the research and development program, not only the kinds of things that Mr. Parker has already mentioned, but also in obtaining full-scale solutions to this problem, the pilot plant and field-scale experiments obviously can be accelerated, and obviously can be extended.

Just how far and how fast one should go, or how far and how fast we are required to go by the development of the industry, is perhaps the basis for further discussion.

Mr. TOLL. Dr. Lieberman, or Mr. Parker, one specific date or deadline that has been mentioned is with regard to the high-level wastes. There is enough tank storage at the present time to take care of perhaps 10 years of anticipated production. Do you think when that 10 years is up we will have solutions, or other ways of taking care of these high-level wastes, or should more tanks be built? Will it be necessary to have more tanks at that time?

Dr. LIEBERMAN. I guess it is always a little dangerous to speak to specific deadlines. I personally feel that within 10 years we will have alternate solutions to tank storage. I would emphasize here, however, that interim tank storage is always, in my opinion, going to be part of this waste management situation. But I don't think that at the end of 10 years we are going to be restricted only to tanks; I think that we will have other ways of handling and managing these high-level wastes.

However, I do not feel that we have to engage in what has been characterized as a crash program. I think we do have the time to go ahead in this program in a very deliberate way, so that we come up with practical economical solutions. I do not think we are confronted with a situation where we have to resort to the erroneous philosophy of "We don't have time to do it right, so let's do it wrong, or let's pour more money into this thing so that we can get it done tomorrow instead of the day after."

I think we do have time to be deliberate. But I think, as has been indicated, we do not have time to waste.

Mr. TOLL. If you had to put your money on one of the various types described as the most likely permanent disposal of high-level waste, various types described, which one would you bet on, right now?

Dr. LIEBERMAN. I am willing to bet, but I don't always win on these wagers.

My own feeling is that conversion of the waste to some kind of solid state, as inert as we can make this chemically, and the disposal or long-term storage into salt structures is a good bet.

I personally feel that, for example, disposal into deep wells, although it has good possibilities, is at this time perhaps a second runner; but, again, I think this is the kind of race, if you set it up on this basis, in which I would not want to put all my money on one horse and then not have him come in.

Representative HOLIFIELD. Is there any general comment on that statement?

Dr. HEROY. I would say that the programs that have been presented here are adequate. That is, I think that the ground has been fully covered that would need to be investigated to determine feasibility and other collateral issues.

But there is, as Dr. Lieberman has said, some question as to the speed with which these things should be advanced.

My own feeling is that in some respects the pace could be moderately accelerated without at the same time getting into a crash program.

Representative HOLIFIELD. Would you care to specify the areas in which you would like to see an acceleration?

Dr. HEROY. I think we might accelerate somewhat the consideration of storage in deep wells, because that, after all, is quite a long undertaking to resolve. And it may be that that should be accelerated.

I think at the present time the problem of storage in salt is probably moving at a reasonably rapid pace. I doubt if we could at the moment accelerate that, although we might be able to do so a little later.

Representative HOLIFIELD. Dr. Taylor, you had your hand up.

Mr. TAYLOR. I do not pretend to be familiar with all of the programs that are going on in connection with the study of sea disposal, but I can't help but feel that in spite of the conflicting evidence that has been presented here, this still has possibilities. I think an increased effort here would probably be worthwhile. We are not faced with the necessity of having to use the sea seriously for a number of years. We could use these years profitably to find out more about the problem.

When it comes to storing packaged waste the way we are doing it now, I personally do not regard this as a serious problem. I think it will be self-limiting.

The problem of putting waste material in containers that will stand the requirements of overland transportation, is such as to almost put a limitation on the amount that you are likely to dump in the ocean. And this, while fairly costly, is a very effective means of disposal as far as we know it.

I think this ought to be examined very carefully before we allow ourselves to abandon it.

Representative HOLIFIELD. Would you take a position as to the disposal of high-level wastes, or low-level wastes, in the ocean?

Mr. TAYLOR. I do not feel that I am qualified to do that, sir. I have the feeling, though, that with further study of the problem, we may find better ways than we can envision at the present time. This is only a feeling.

Dr. PRITCHARD. I am Dr. Pritchard of the Johns Hopkins University.

I feel there may have been some misinterpretation of testimony given, both by Dr. Revelle and myself, in regard to the utilization of the marine environment as a receiver of nuclear wastes.

One possible misinterpretation came up and was referred to just a short while ago in regard to our statement concerning the fact that under certain conditions the maximum permissible concentration of certain isotopes in the marine environment would be factors of a thousand less than that in drinking water.

We must remember, first of all, that here we are talking about the meaning, first of all, of maximum permissible concentrations, which imply exposure of man of a 30-year-or-more period, and hence we are talking here about short-time or local concentrations, which we recognize may well exceed these limits.

Second, the computation or the determination of maximum permissible concentrations in the marine environment, which may turn out to be less than those proposed for drinking water, are based upon an evaluation of man's utilization of the marine environment, that is, utilization of the products of the marine environment.

Hence, these factors would only come into play if we are dealing with that portion of the marine environment which man utilizes intensely.

Representative HOLIFIELD. Which tends to concentrate the lower level into a more concentrated form?

Dr. PRITCHARD. Right. Now, if we are dealing with a portion of the marine environment in which man's utilization is far removed, then the maximum permissible concentrations in that portion of the marine environment may be several times the maximum permissible concentration in drinking water.

And I refer, for instance, to the deep ocean. And in the deep ocean in which the utilization by man is far removed and the processes of admixture and diffusion are such that by the time they refer to the areas utilized by man, the concentrations would be greatly reduced, the maximum permissible concentrations in the deep ocean may be quite large.

So I wanted to clarify that. I do feel, however, in regard to these programs, just this matter of the evaluation of the routes from the marine environment to man requires more intensive study, in order that we do not impose restrictive limitations upon this growing industry because of lack of knowledge. And I believe that the programs have been initiated, but they need more support.

Mr. GORMAN. There is one aspect of waste disposal that does not seem to me to have been covered in any of these discussions, and that is the transportation of waste. We talk about disposal at sea in a selected disposal area; but you have to remember that those wastes have to start from a dock, go through the harbor, out the harbor outlet

into the open sea, and finally get to this area you are going to dump it in. But what are the hazards between dockside and the ultimate point of disposal?

There are many, as we all know, in experience with marine accidents. The same thing is true here. We are going to dispose of waste in Idaho, shipping them maybe 3,000 miles. I think there should be and of course I know there are studies.

There should be a real evaluation of the environmental risks that are involved in a long shipment of waste as compared with short-term hauling, and local either burial or warehousing in a safe place underground.

These are an integral part of waste disposal. And we must remember that a well organized atomic energy facility, once it has an accident, all that is left, pretty nearly, is waste. So you have to think of that phase of it, too.

And I would like to see, if it isn't too late, that information be put in your document on waste disposal so it will show the current situation with reference to transport of radioactive materials in wastes, the thinking of the industry, and the contractors, and perhaps what discussions they have had with our Interstate Commerce Commission.

Representative HOLIFIELD. I think you have made a valuable suggestion. And I was going to ask if there had been any areas which the hearing had not encompassed. I think this is one that does need further information, and the committee will endeavor in one way or the other to get information on this for our hearings.

Now, as long as we are on the subject of areas which may not have been covered, or may have been covered inadequately, are there any comments or recommendations which any member of the panel would like to give the committee in further completing its work on this subject at this time?

Are there any other fields we may not have covered adequately?

Mr. TOLL. Mr. Chairman, I might mention that the oral testimony has not touched very much upon disposal from nuclear powered ships, but the committee has received for the record statements from the Naval Reactors Branch of the AEC and from the Maritime Administration as to disposal from nuclear powered ships, and this will be included in the public record of the hearings.

Maybe this is an area on which additional information should be obtained, also.

Mr. GORMAN. Will that be with reference to any one ship, or what the situation will be when the Nation has a hundred nuclear powered ships?

Mr. TOLL. The information in the Maritime Administration statement deals primarily with the *Savannah*, in which the waste will be completely contained, but it also looks forward to further nuclear propelled merchant ships, where it states that plans should be made for disposal from such ships of limited amounts of low-level waste.

Mr. GORMAN. Then there is the other aspect with the deep waterways going into the Great Lakes. Someone should be seriously considering the division between the nuclear propelled ships in salt waters and nuclear propelled ships in fresh waters which are sources of public water supply to the very large cities.

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Those problems became quite acute on the Great Lakes, I know from experience, when small ships from foreign countries discharged ballasts into our fresh water lakes in the same way they do in a salt body of water; and the resulting impact is quite different. So it has to be weighed on the basis of what is ahead.

And I would like to see somebody analyze it on the basis of when there are a hundred nuclear propelled ships in this country, instead of one or two or a few submarines.

Dr. PRITCHARD. Mr. Chairman?

Representative HOLIFIELD. Dr. Pritchard.

Dr. PRITCHARD. I would like to restate the fact that there is a National Academy of Science committee dealing with this specific problem of the disposal of nuclear wastes from nuclear powered merchant ships, and this committee, of which I am chairman, will treat the question of the problems which will exist when we have something like 300 ships with nominal 60 megawatt——

Representative HOLIFIELD. When will your report be ready?

Dr. PRITCHARD. This report is due to be presented to the parent committee, the Committee on Oceanography of the National Academy of Science, on the 5th of March. And while I gather it will be too late to be included in this testimony, it certainly will, when cleared through the parent committee, be supplied to this committee for your attention.

Representative HOLIFIELD. You do not know how long it will take to clear it before the parent committee?

Dr. PRITCHARD. I would hope that they will be satisfied with our drafts on the 5th of March, at which time I am sure that Mr. Lieberman, whose group we have been closely working with, can supply your committee with a copy—sometime during March.

Representative HOLIFIELD. I will ask you to confer with the staff on this matter, and it may be that we can keep the record open long enough to get the benefit of this study.

Mr. TOLL. Mr. Chairman, on the matter of transportation, which Mr. Gorman raised, Dr. Dalzell has under preparation a report on this matter.

Mr. Lieberman, could you tell us when that will be available?

Dr. LIEBERMAN. The short answer to the last question is, "No." I cannot tell you when it will be available. It is being worked on actively at the present time. Obviously, we are concerned specifically and intimately with the transportation problems, and as Mr. Gorman indicated, there are studies going on. There is a group who it is stated are now active—it is composed of representatives from the AEC and its contractors—to accumulate the technical information and experience related to the transportation of highly radioactive materials. We hope that this information will subsequently be utilized in a review and perhaps a reevaluation and a redrafting of existing regulations pertaining to this subject.

I am sure there are other members of the panel that can speak more specifically on this point; but it is my understanding, for example, that the present regulations that are under the jurisdiction of the Interstate Commerce Commission relating to the transportation of radioactive materials have at their roots or the basis for this regulation the protection of X-ray film in transit. These things were de-

veloped, I think, back in 1947, and Dr. Taylor is, I am sure, more familiar with the details, but, obviously, at this stage of development of the nuclear energy industry, this is perhaps no longer a reasonable basis for regulations; so that this study group that is, as I say, active, hopes to come up with the technical information that perhaps is a better basis for establishing regulations in this aspect of the industry.

We are right now in the process of trying to get together a draft of this report, but we have been trying to do this for the past 6 months to a year now.

Mr. TOLL. Well, if some of these reports and studies can be accelerated, it might be possible for us to utilize them by having our committee print made and holding it for the final edition, before final or permanent printing, for a little while longer, in order to get as much as possible in the record of the hearings.

Representative HOLIFIELD. Now, are there any questions which any member of the panel wishes to ask any other member in regard to the statements which have been made, either for the purposes of clarification or for the purpose of bringing more information out on that particular subject?

Any questions, Dr. Rodger?

If not, then, gentlemen, in concluding these hearings, I wish to express, on behalf of my colleagues on the committee, our appreciation for your time and your efforts and for the presentations which you have made. I am sure they will result in a very valuable document for exchange among all of you and throughout the industry and throughout the colleges and universities of our country.

I also wish to thank the spectators for their presence and their bearing through these long sessions with the witnesses and the chairman and the members of the committee.

Before we adjourn I have several general papers to be inserted in the record.

(The material referred to follows:)

STATEMENT ON ACTIVITIES OF THE INTERNATIONAL ATOMIC ENERGY AGENCY IN THE FIELD OF DISPOSAL OF RADIOACTIVE WASTE, BY STERLING COLE, DIRECTOR GENERAL

The disposal of radioactive wastes is a matter of importance throughout the world and of particular concern to the International Atomic Energy Agency in carrying forward the work of spreading the benefits of the peacetime production and utilization of atomic energy and at the same time protecting public health and marine resources.

The objectives of the Agency, which was established under the impetus of the "atoms for peace" program inspired by President Eisenhower's proposals to the United Nations and now includes 70 member states, are to "accelerate and enlarge the contribution of atomic energy to peace, health, and prosperity throughout the world."

This can only be done in an atmosphere of worldwide public confidence that the potential hazards in the utilization of nuclear materials are properly controlled. Such control demands, among other things, uniformly effective measures for the handling of radioactive wastes in every part of the world and particularly that part which lies in international domain. The responsibilities of the Agency in this field were indicated in the original planning and organization by the establishment of a Division of Health, Safety, and Waste Disposal.

The United Nations Conference on the Law of the Sea, in April 1958, recognized the need for action in the field of the disposal of radioactive wastes at sea. The Conference recommended that the International Atomic Energy Agency, "in consultation with existing groups and established organs having competence in the field of radiological protection, should pursue whatever studies and take

whatever action is necessary to assist states in controlling the discharge or release of radioactive materials to the sea, in promulgating standards, and in drawing up internationally acceptable regulations to prevent pollution of the sea by radioactive materials in amounts which would adversely affect man and his marine resources."

The staff of the Agency began preliminary studies along these lines during the summer of 1958. The need for action at the international level was further emphasized at the Second United Nations Conference on the Peaceful Uses of Atomic Energy in Geneva in September 1958. The Second General Conference of the International Atomic Energy Agency, meeting in Vienna in September and October, approved a program of work in this field, providing funds for the activities for this purpose in 1959. The Third General Conference in September of this year, will be asked for funds for the expansion of these activities.

To establish the foundation in principle and provide the framework for broad and coordinated action among the nations to prevent harmful pollution of the seas, the Director General named a panel of experts advisers under the chairmanship of Mr. Harry Brynielsson, Chairman of the Swedish Atomic Energy Commission.

Other members of the panel are Dr. Colin A. Mawson, of Canada; Prof. Frantisek Behounek and Prof. Vladimir Vesely, of Czechoslovakia; Dr. Pierre Cohen, of France; Mr. J. B. Schijf, of the Netherlands; Prof. Nobufusa Saito, of Japan; Dr. Bo Aler, of Sweden; Mr. H. Howells, of the United Kingdom; and Dr. Donald W. Pritchard, of the United States. Observers representing the United Nations, the World Health Organization, and the Food and Agriculture Organization have attended the two sessions of the panel which have been held so far in Vienna, in December 1958 and March 1959.

Individual members of the panel, of course, have continued to work with the staff of the Agency's Division of Health, Safety, and Waste Disposal, which is headed by Dr. G. W. C. Tait, formerly in charge of the health physics work at the Chalk River installation of the Canadian Atomic Energy Commission. Working parties have been formed to prepare the initial drafts of the various reports, findings, and recommendations which the panel hopes to complete this fall.

Certain aspects of the work of the panel will be considered by a conference on radioactivity waste disposal to be convened at Monaco in November. The conference will be sponsored by the International Atomic Energy Agency in cooperation with other United Nations organizations and will bring together specialists from all parts of the world for a review and discussion of the entire problem.

The Agency's Division of Reactors and Division of Health, Safety, and Waste Disposal, have recently begun preliminary studies of the problems which might be encountered with the widespread use of nuclear propulsion for ships. The work was begun at the request of a member state and plans are underway for the convening in the near future of expert advisers from the fields related to the safety of life at sea and safety in ports, all involved in the question of the use of nuclear power aboard ship. The Agency expects to sponsor a special conference late this year to consider certain technical problems related to nuclear propulsion in preparation for the World Conference on Safety of Life at Sea in spring of 1960.

The number of organizations—national, intergovernmental, and international nongovernmental—historically and directly concerned with the various facets of radiological protection and its application to many fields of activity in industry, agriculture, research, medicine, and transport, creates in itself an unavoidable problem of coordination and definition of functions and responsibility.

The International Atomic Energy Agency, in addition to its direct responsibilities in connection with Agency-sponsored nuclear projects, acknowledges its obligations with respect to the general health and safety problem of atomic energy development. The Agency is therefore working closely with the existing bodies in the field, including the United Nations Special Committee on Atomic Radiation, the long-established nongovernmental commissions on radiological units and radiological protection (ICRU and ICRP), the World Health Organization, the International Labour Organization, the Food and Agriculture Organization, the International Meteorological Organization, the Intergovernmental Maritime Consultative Organization, and a host of other agencies and

organizations concerned with public health and safety problems in transport and industry.

The Agency has also started work in the field of the safe handling of low level radioactive materials in transit, including the establishment and application of internationally acceptable packaging standards and the regulation of all aspects of transport and transit storage. There is at present great disparity in the conditions under which radioactive materials may be shipped in various countries. The problem will be of critical importance as the use of nuclear fuels for power expands with its concomitant of transport of highly radioactive irradiated fuel elements.

A panel of advisers, including specialists from France, the U.S.S.R., the United Kingdom, and the United States, but consisting mainly of the representatives of the international transport organizations, convenes in Vienna in April. The advisers will include experts concerned with the technical as well as the international problems of transport safety in the air, on land and at sea. The group will be headed by Mr. Gaston André, Director of the Radium Department of Union Miniere du Haut Katanga, Belgium.

A subsequent panel will undertake studies of the problem of standards and regulations to govern the shipment of highly radioactive irradiated fuel elements. Work has already started within the staff of the Agency on this problem.

IAEA has a special responsibility in assisting the atomically less advanced countries with respect to nuclear health and safety problems. One of its first tasks was to provide guidance for the constantly growing lists of new users of radioisotopes. Through the preparation and publication of a manual on "Safe Handling of Radioisotopes," recommended approved practices, based on the experience of the advanced countries, have been made available to all countries. This work was under the direction of a panel headed by Dr. Gunnar Randers, of Norway.

The manual included a special section on radioactive waste disposal and control. While the manual was largely for the small-scale user of isotopes, the waste disposal information will be of assistance to a large class of users. Publication of this guide is an example of the important service to the agency in making available to the countries which have only recently entered the atomic field the experience of the nations with broad atomic development programs.

The Agency's review of the various approaches taken by the advanced nations toward the problem of waste disposal reveals a diversity of highly local and specialized solutions. A substantial part of the Agency's budget for contractual scientific services is therefore allocated to studies of waste disposal problems along the following lines:

1. Collection and assessment of information on current practices.
2. Study and selection of methods of waste disposal adaptable to the needs of the less advanced countries.
3. Marine studies related to waste disposal at sea.
4. Studies of limitation on disposal into fresh waters.
5. Collection and evaluation of information on the behavior of isotopes in various types of soil.

Comments on the Hearings on Waste Disposal by Ralph E. Lapp

The investigations into the problems associated with the disposal of radioactive waste products serve the valuable purpose of illuminating a field which will become of increasing importance with each passing year. In reviewing the testimony of the various witnesses I am impressed with the fact that (a) many of the problems are unsolved at present; (b) radioactive debris enters into complex and incompletely understood relationships in our biosphere; (c) there has been no major reactor accident resulting in serious local contamination; and (d) public reaction to nonweapon radiation hazards has been sporadic and localized.

Your hearings did not occasion the interest on the part of the public which the fallout investigations of 1957 aroused, largely, I assume, due to the lower emotional content of the subject of reactor hazards. This situation could change overnight should there be a major accident with a large reactor. If, for example, a nuclear-powered submarine were to be sunk in a harbor as a result of a collision, the resulting contamination would undoubtedly be serious and would persist for a long period of time. It is pertinent to note that such a harbor accident becomes more probable as more nuclear-powered vessels are put

into operation; it is not so much a problem of reactor safety as it is a matter of collision probability.

Presumably discussion of mobile reactor hazards was beyond the scope of the waste-disposal topic, but it does represent an acute form of the problem and deserves serious examination. It is to be hoped that the Joint Committee will hold open hearings on the subject of mobile and propulsion reactor hazards in the near future. The National Academy of Sciences study (Committee on Oceanography) of the hazards involved with a total of 300 nuclear ships of 60-megawatt powerplant capacity should serve as a point of departure for such hearings. In addition, there should be thorough discussion of the contamination risks involved in operation of nuclear-propelled aircraft.

A special category of atomic development which requires careful analysis is that involving the peacetime detonation of nuclear explosives for mining and engineering applications. Prominent AEC spokesmen such as Dr. Edward Teller have written in glowing terms of the extensive use of "atomic dynamite." The AEC's Project Plowshare envisions such applications as the blasting of surface ore, copper-bearing ore, for example, or the extraction of oil from oil shales. Such applications involve serious contamination hazards both from fission products and from induced activities in the event that low-yield fusion devices are perfected. If one takes these applications seriously, would an industrialist be required to apply for a license from the AEC? If so, would the AEC's Division of Licensing and Regulation be the group which would evaluate the risks involved?

The Atomic Energy Commission has an Advisory Committee on Reactor Safeguards to evaluate specific aspects of reactor safety in reactors proposed for construction. Perhaps it would be desirable to expand the function of this committee to include all nuclear hazards, whether associated with reactors, weapons tests, large-scale isotope applications, or nonweapons applications of nuclear explosives. Or it might be advisable to establish a Division of Radiation Safety within the framework of the AEC.

Such questions as these bring into focus the dilemma of a Government agency which is charged with the responsibility for development and operations while it is also held accountable for the evaluation of the hazards engendered by its own activities. It seems to me that it it unfair to impose such dual responsibilities upon a single Government agency. Sooner or later the developmental and the regulatory responsibility conflict; we have seen this in the case of the evaluation of fallout risks attending bomb tests. Indeed, I was struck by the testimony of the AEC witnesses in this respect; they evidenced great respect for radiation hazards, took pains to minimize the hazards and emphasized the deficiencies in present knowledge about the waste disposal problem. This attitude contrasts with the manner of AEC spokesmen who have reassured the public on many occasions that nuclear test hazards are negligible.

There is a real dichotomy in the Atomic Energy Commission so far as radiation hazards are concerned. On one hand the waste products of the huge production plants at Hanford, Wash., and at the Savannah River installation are carefully stored in leakproof tanks, diluted in many millions of gallons of wastes. On the other hand, the selfsame waste products produced in nuclear explosions are hurled into the air and committed to the global atmosphere beyond the control of man. I estimate that waste products equal to the first 10-year production at Hanford has been released to the atmosphere. The fission products are identical whether produced slowly in the atomic ovens at Hanford or in a split second inside an uncontrolled nuclear reaction.

Another example of the dichotomy existing within the AEC as related to radiation hazards is the fact that during the fallout hearings of 1957 the experts of that agency informally agreed to a 10 megaton annual limit as the safe rate of testing. It is noteworthy that no AEC witness proposed that reactor wastes even to a minute fraction of this number be allowed to escape into the atmosphere.

So far as the free release of radioactive material to the air is concerned the only radioactive emitter of long half life which is allowed to escape from reactor installations today is krypton 85. Yet during the present hearings there was no quantitative discussion of the present hazard from this radio element. Dr. F. R. Bruce did state that by the year 2000 there would be some 700 megacuries of Kr^{85} generated and this would constitute an increase in the natural background and that "it will eventually be necessary to remove the rare gases from chemical plant waste and retain them for decay." The specific hazard here is still relatively small but it would be useful to have data on krypton 85

available in the unclassified literature so that scientists may learn more about the transport and dispersion of radioactive gases. My calculations show that there should be about five disintegrations per minute for a kilogram of air. It should be possible to measure this krypton activity especially with our advanced gas liquefaction technology. Certainly data on the global distribution of Kr^{85} would help to clear up some aspects of the strontium problem.

An additional waste disposal problem which merits consideration is the ultimate fate of separated fission products or induced activities which are produced in high yield by fission or fusion devices. I have in mind such emitters as strontium-90 and cerium-144. A variety of military and industrial applications for encapsulated strontium-90 are possible and may be exploited providing proper radiation precautions are exercised. The integrity of the hermetic seal for the source containers should be subjected to rigorous testing and the source should be subject to radiation control throughout its projected period of potential hazard. This process will necessarily involve long-term recordkeeping.

It is an unavoidable feature of the radioactive release of energy that such sources present a potentially serious health hazard. For example, a small SNAP power source for application in a space vehicle might involve 30 kilocuries of strontium-90 (beta-emitters involve an order of magnitude less energy per disintegration than alpha-emitters). The level of contamination with strontium-90 which is sufficient to deny peacetime utilization of farmland is not presently defined in terms of activity per unit area of land. I believe, however, that most experts would agree that a level of 1 curie per square mile (about 50 times the contamination present in many areas in the Temperate Zone) would be considered as a "denial level." If one assumes a limiting activity of 1 curie of strontium-90 per square mile then the total release of 30,000 curies to the environment would present a theoretical maximum of 30,000 square miles of excessively contaminated farmland. The danger focuses upon the rupture of the sealed source during takeoff or upon destructive reentry. The malfunction of an Atlas missile on takeoff would subject a sealed container to severe mechanical impact and to elevated temperatures. It would clearly be prudent to establish a rigid safety standard governing the extrahazardous applications of kilocurie quantities of radioactive material.

Recognition of the radiation hazard is a first step toward proper radiation control but this does not insure that the hazard will be fully respected. For example, within a few months after Roentgen's discovery of X-rays, it was recognized that these rays could produce biological damage. Yet decades later people still refused to respect the hazard. As a result there were many unnecessary deaths and injuries which could have easily been avoided by taking simple precautions. It is significant that many scientists suffered radiation injury. Both Madame Curie and her daughter died as a result of overexposure to nuclear radiation.

It was not until three decades after the discovery of X-rays that the International Commission on Radiological Protection (ICRP) was established. Prior to this time scientists recognized the hazard and in fact understood the concept of a permissible safe annual dose of radiation. It took the establishment of the ICRP to formalize these nonuniform concepts into standards which could be applied to occupational groups.

In the attached reprint reference is made to the fact that the "permissible" amounts of radiation reckoned on a per annum basis have decreased steadily over the years as more information became available on the biological effects of radiation. It should be emphasized that until very recently the ICRP put forth recommendations specific to occupational groups of healthy adults working under controlled conditions of exposure to radiation hazards. Only recently has attention focused upon the problem of establishing radiation limits for large or total populations. Here one has to consider not only the larger numbers of people involved, but also their varying response to radiation. Ten factors which have to be considered are discussed on page 25 of the attachment. In many areas there is an inadequate scientific and technical basis for establishing radiation limits for a global population. There is an obvious need for concentrating research in an effort to obtain data which will permit establishing radiation levels on a sound basis. Furthermore, it must be recognized that the current recommendations of the ICRP and its parallel group in the United States of America—the National Committee on Radiation Protection and Measurement (NCRP) have no legal status in this country.

The probable growth of the nuclear power industry as well as the increased applications of nuclear radiation make it mandatory that proper radiation

controls are brought into being to protect the public welfare. Although the Atomic Energy Commission has demonstrated a remarkable control over radiation within its laboratories and production plants, it is now apparent that the problem is mushrooming far beyond AEC sites and demands careful regulation. Since radiation constitutes a part of the public health problem, it would appear reasonable and proper to create a radiation control and evaluation authority within the Public Health Service.

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Radiation and Man: Basic Data—Global Radiation Limits

(By Jack Schubert [1] and Ralph E. Lapp [1])

Until the advent of nuclear energy one could consider manmade radiation sources as localized in character. There was no need for considering limits to the radiation exposure of the world's population. It was for this reason that interest focused on establishing "permissible limits" for relatively small numbers of adults occupationally exposed to radiation hazards. The large-scale release of radioactive products into the earth's atmosphere and the subsequent deposition of these materials on the earth's surface attracted public interest and initiated controversy. Public and scientific anxiety over the biological consequences of radioactive fall-out argues for the setting of a maximum permissible level for a general population or a General Population Limit (GPL) as opposed to an Occupational Permissible Limit (OPL).

In a sense it is fortunate that global fall-out from bomb tests focuses attention on radiation hazards, for the expanding use of nuclear reactors, both stationary and mobile will sooner or later force establishment of a GPL. What is to be regretted is that scientific knowledge about the ultimate biological effects of radiation at low levels is inadequate to deal quantitatively with all aspects of the problem.

It may be formulated as a single question: How much radiation above the natural radiation (background) which everyone receives may be "allowed" without incurring harm to a significant segment of the world's population? We may liken the problem to cutting a third notch on a yardstick which already has two notches, one being the natural background and the other being the OPL. Somewhere between these two notches the GPL is to be fixed.

Before we can proceed to discussing where the GPL notch goes, we must obviously investigate the position and meaning of the levels corresponding to the natural background (NB) and the OPL. And we must define these levels in terms of appropriate units. Since one has to deal with different types of radiation the most meaningful unit is the roentgen equivalent man (rem).

The base point on the radiation yardstick we shall call the Fixed Natural Background, defined as that amount of radiation received by a standard man throughout a life span of 70 years. Since the annual background dose (Reference 1, p. 1240) is approximately 0.134 rem (0.030 rem from cosmic rays, 0.060 from the earth's surface and 0.044 from internal emitters, all referred to dosage of the bone marrow), it seems logical to stipulate 10 rem as the lifetime dose for the Fixed Natural Background (FNB). The authors propose that any General Population Limit for radiation be fixed as a multiple of the FNB rather than as a fraction of the OPL. We realize that the natural radiation background varies from region to region and for different heights above sea level, and so on. However, even though arbitrary, the fixing of an exact value for the NB provides many advantages as has been found in analogous situations as witness the "standard man" and the "curie."

Before proceeding further, we must examine the history and philosophy attending the relative position of the OPL (2, 3). Reports of radiation injury to dozens of individuals began to appear in the literature within a few years after Roentgen's discovery of X-rays (1895). As early as 1902 attempts were made to define a "tolerable" dose of radiation. In 1911 a monograph was published by O. Hesse who gathered statistical data on 94 cases of radiation-induced cancer some of which evidenced latent periods of a decade (4).

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[1] Ralph Lapp, physicist and lecturer, and Jack Schubert, Senior Chemist in the Division of Biological and Medical Research at Argonne National Laboratory, are coauthors of the recent book, "Radiation: What It Is and How It Affects You."

The International Committee on X-ray and Radium was formed in 1928 and renamed in 1937 as the International Commission on Radiological Protection (ICRP). This group defined Permissible Dose as "a dose of ionizing radiation that, in the light of present knowledge, is not expected to cause appreciable bodily injury to a person at any time during his lifetime." The "present knowledge" at that time was derived largely from human experience with a small number of gross overexposures to X-radiation; thus the word "appreciable" by-passed more subtle effects of radiation damage. In addition, the concept of damage occurring during a lifetime was admittedly weak since there were very little statistical data on long-term radiation effects. It is thus understandable that suggested values for the maximum permissible dose should have been constantly lowered throughout the past half century. Table 1 illustrates the manner in which the official and quasi-official estimates for permissible levels (occupational) have changed for external radiation sources. The most recent change apparently represents a strong recognition of the importance of genetic considerations and of others such as shortening of life.

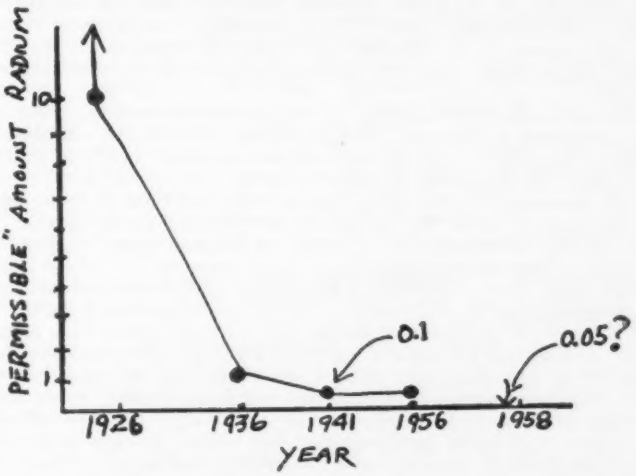

FIGURE 1

With regard to permissible levels for internal emitters, principally radium, the record of the past half century begins with the curious notion—which persisted for many years—that radium had a beneficial effect upon humans. For example, as late as 1917, C. E. Field wrote: "Radium has absolutely no toxic effects, it being accepted as harmoniously by the human system as is sunlight by plants." (5). Figure 1 illustrates how the suggested permissible levels for radium in occupationally exposed individuals have been changed since the first limits were established. If we look upon radium retention in humans as a problem in toxicology, it is understandable that the OPL is not regarded as an absolutely safe limit but rather as a level which is subject to constant revision and re-evaluation. Because of the nature of the evaluation process, much depends upon the background and outlook of the evaluators.

TABLE 1.—*Occupational radiation limit to total body from external radiation sources*

Year:	*OPL (r/year)*
1902	2500
1925	100
1931	50
1936	25
1948	15
1956	[a] 5

[a] The dose rate is based actually on accumulated exposures received. The maximum absorbed dose to total body that could be accumulated from occupational exposure was set at 5(A–18) in which A is the age in years. This limit on accumulated exposure amounts to an average dose rate of about 5 rem per year.

Who sets limits?

Initially, those who formulated the ICRP recommendations were either physicians or physicists associated with medicine. The outlook of most physicians was limited to short-term and visible effects of radiation; many even today regard the genetic effects of radiation as "theoretical." Radiologists accustomed to therapeutic radiation dosages measured in the hundreds or thousands of roentgens seem to find it difficult to believe that much smaller amounts of radiation may be harmful. Consider the membership of the influential U.S. National Committee on Radiation Protection (NCRP): of the 36 members, nearly one-half are physicians, 8 representing radiological groups, and the others representing the military and industry, while nearly all the rest are physicists, with a few representing manufacturers of radiation equipment. Essentially, no "pure" scientists representing such fields as cellular physiology, biochemistry, genetics, trace element metabolism, and biostatistics are on the committee. The NCRP, being the principal committee concerned with all aspects of radiation, should represent a wide spectrum of scientific fields—one made up of all geneticists, for example, is no more qualified than a committee consisting only of physicians, or statisticians. One of the underlying reasons why the recommendations of the report of the National Academy of Sciences (1956) clashed with NCRP views is probably the different membership of the advisory committees involved (6).

A constant argument in radiation protection circles has been the question of how much radiation it takes to produce cancer in humans. Many radiologists and biologists subscribe to the contention given in many textbooks that a dose in excess of 1,000 r is necessary to induce cancer. Values of 1,000 to 3,000 r are stipulated as necessary for the induction of lung and bone cancer. Studies published in 1950, based upon late follow-up of children given thymic irradiation with X-rays, point to radiation dosages in the neighborhood of 200 r as inducing thyroid cancer. Subsequent publications have substantiated these initial results (7). British data, first published in September 1956, indicated that many types of cancer were induced in children exposed in utero, generally in the 8th or 9th month, as a result of pelvimetric X-rays (8). Intravaginal dose measurements yield a total average of 2.9 r for a series of 4 pelvimetric films (9). That such small amounts of radiation may induce cancer in human tissue has been questioned (10), but the completed study, not yet made public, bears out the preliminary reports. The data compiled by Dr. A. Stewart and her colleagues from a study of more than 1,500 children who died before the age of 10 from malignancy of all types shows that a history of irradiation in utero (i.e., a pre-natal abdominal X-ray) was obtained nearly twice as frequently from the mothers of children who had died from leukemia or cancer as from the mothers of live controls. If these observations are confirmed, the whole problem of the carcinogenic effects of radiation must be re-evaluated.

Factors to be considered

It may be hoped that future research will illuminate the induction of somatic effects by radiation in the range of a few roentgens. But the present data should make for extreme caution in the establishment of the GPL. The following considerations, however, also apply:

1. *The nature of relative risk.*—In the past the numbers of people involved in occupational exposure to radiation have been relatively small, so that calculation of the risk to a total population raises new problems. A probability of 1 injury per 100,000 individuals exposed would be a small risk for a laboratory group but for the world's population it would involve harm to 28,000 individuals.

2. *Sensitive groups.*—A large population includes a nonuniform sample in contrast to the selected sample in occupational exposures. The latter consists of healthy adults, educated in risks, voluntarily exposed to known hazards under administrative and medical supervision. Those establishing the GPL must recognize the sensitivity of the most critical age, health, or genetic group. The GPL must also reflect consideration of the individual in utero if this is the most sensitive phase of a person's exposure to radiation.

3. *Lifetime radiation effects.*—Delayed and subtle somatic effects of radiation become of great significance when one applies the concept of a radiation limit to a total population. The medical profession has only limited data on late effects of radiation, usually limited to followup studies of a few years or decades after irradiation. Very few data exist for half-century delayed effects and these in-

volve individuals originally exposed as adults or in late adolescence. Information on delayed radiation effects on children is urgently needed in considering the GPL since many millions of persons are irradiated even before birth. For example, about 400,000 children are irradiated in utero in the United States each year as a result of X-ray pelvimetries—one woman in four has a routine pelvimetry before the birth of her first child (11).

4. *Genetic effects.*—Obviously the genetic factors become of great importance when formulating a GPL. The NCRP suggested in January 1957 that: "The maximum permissible dose to the gonads for the population of the United States as a whole from all sources of radiation, including medical and other man-made sources, and background, shall not exceed 14 million rems per million of population over the period from conception up to age 30, and one-third that amount in each decade thereafter." Of the 14 million rems, 4 million rems are from the unavoidable natural background.

5. *Biospheric variations.*—Deposition of airborne radioactive particles shows irregular patterns depending upon the geographic source of original radiation, the meteorology, soil conditions, terrain, and the type of agriculture. These variations will be superimposed upon differences in diet and human factors which lead to retention of radioactive substances in humans.

6. *Ecological factors.*—Upset to the ecological pattern of an area can result from changes in a single ecological link. Concentration of a radioelement by a species must be considered. The radioactivity of plankton average several thousand times higher than the surrounding sea water.

7. *Statistical distributions.*—It is of importance to know what distribution pattern traces of radioactive substances exhibit on being retained in humans. One may fix the GPL on the basis of an average value, say for strontium 90 retained in bone, but the critical feature for a global population is the extent to which a segment of this population will retain twice, three, four or more times this average.

8. *Psychological factors.*—Scientists may recommend certain values for a GPL, but acceptance of these recommendations by the general population is another thing. This has been demonstrated rather graphically on a number of occasions when the public was confronted with a radiation hazard. The Japanese response to contaminated tuna fish is a case in point (12). Radiation levels established by the American tuna industry clearly reflect the view that the consumer sets the standard for acceptability of radioactivity in canned tuna.

9. *Future knowledge.*—Present knowledge of human physiology is not adequate to preclude scientists' "stubbing their toes" in extrapolating studies on chronic or delayed effects of radiotoxic substances in humans. This is especially true when one looks into the allied field of toxic chemicals such as beryllium compounds (13). Unexpectedly it was found that inhalation of minute amounts of certain forms of beryllium could produce a disabling lung disease known as berylliosis. The latter might follow many years of good health after the intake of the toxic chemical. It was a surprising discovery that many individuals in communities adjacent to beryllium plants were afflicted with berylliosis even though the concentrations of the toxic material were thousands of times less than in the plant. The permissible exposure levels of beryllium for the general population living in the vicinity of a beryllium plant has been set by the AEC at 200 times less than for occupational groups. The history of toxicology is replete with many other examples of recognition of hazards and setting up of limits only after serious or lethal effects were observed.

10. *Adequacy of biological data.*—Extension of radiation levels from small populations to 2.8 billion people makes it mandatory that there be an adequate biological base for predicting the ultimate effect of radiation upon so many individuals. In the case of globally distributed strontium-90 the evaluation of the toxicity of this additive to the human internal environment is based upon some 80 published case histories of radium retention in humans. Only a fraction of these individuals were reported to have radium levels in the area of interest, i.e., chronic, low-level damage. Additional radium-burdened humans have been found in the past few years and the total may run to several hundred cases.

About 15 individuals in every million become afflicted with bone cancer each year. Now even if this rate were increased tenfold by an amount of radium corresponding ot the OPL this would still mean less than one case of bone cancer would be found in a thousand cases. It is obvious, therefore, that conclusions as to the toxicity or lack of toxicity of radium and hence strontium-90

drawn from a handful of cases are statistically meaningless. While no bone cancer was found in patients having less than 0.4 microgram of radium, patients who had 0.5 to 10 micrograms of radium had a bone tumor incidence of 14 percent. From these latter data it can be calculated that the probability of bone cancer from the retention of 0.01 microgram of radium (the GPL) is 1 in 2,000 cases in 30 years (assuming the worse—complete linearity between radium content and bone cancer induction). This would amount to nearly 100,000 additional cases of bone cancer in the U.S. population alone in a 30-year period.

It is apparent that the biological basis for evaluating the global strontium-90 hazard is by no means firm. Considering the shakiness of the base, it is difficult to understand the confidence with which some scientists, officials, and others have voiced optimistic predictions about the nature of this new hazard.

This tabulation does not necessarily end with the recital of these 10 topics for there are other aspects of the global problem which could be added. When one comes to consider the overall problem it is inescapable that the final decision on the GPL will consist of a value judgment and a calcultated risk. A certain risk must be taken in order to obtain the great benefits which accompany the use of radiation. A humanist would argue strongly for allowing no radiation which could add to human misery; a geneticist would plead for no level which might add significantly to the genetic overload of future generations; and a somatologist, conscious of the limitations of present knowledge, might well argue for levels stipulated by the geneticist.

The present custom in stipulating a value for the GPL is to set it as some fraction, often one-tenth, of the OPL. An obvious disadvantage is that the OPL is arbitrary and has been subject to many downward revisions. Furthermore, values for OPL's vary from one country to another. Some extremists have suggested GPL's at such a fraction of the OPL that below-background values result. Setting the GPL as a multiple of the FNB (10 rem) would resolve these difficulties.

Within reason and practicality, the GPL should be based upon the harmful effects expected to result from the smallest dose of radiation to a significant segment of the world's population. If we have a choice between a lower and a higher GPL, within the bounds of present knowledge, we should choose the lower one, if it permits us to carry on our essential activities involving the use of radiation. Emphasis should be placed upon genetic factors, and on possible especially high sensitivity of the developing embryo, in stipulating the GPL. Of future importance is the point that the potential hazards from radiation must be discussed not only in terms of "average" dose but also in terms of the fraction of the population who will exceed the average by two, three, and more (14).

Summary

It is proposed that international agreement be reached on establishing radiation limits applicable to the world's total population. Such a General Population Limit (GPL) would be at some point intermediate between the Fixed Natural Background (FNB) to which everyone is exposed and the OPL (Occupational Permissible Limit) set for small numbers of individuals occupationally exposed to radiation. It is proposed that the GPL be taken as a multiple of the FNB which in turn is fixed at 10 rem. The factors which enter into consideration of the global radiation limits are enumerated and contrasted with those involved in setting the present occupational levels.

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Statement of the Commissioners' Court of Harris County, Tex., Concerning Radioactive Waste Disposal Problems

We have asked L. D. Farragut, M.D., director of the Harris County health unit, and W. A. Quebedeaux, Ph. D., director of the air and water pollution control section of that unit, to help us prepare this statement because they are the two individuals closer to these problems in our county. We wish to thank the special subcommittee of the Joint Committee on Atomic Energy and the Honorable Chet Holifield, chairman of that committee, for allowing us the privilege of presenting our views on this important subject. In order that we might have the benefit of the latest information, Dr. Quebedeaux was sent to Washington to listen to the presentation of the statements of other experts who came before this special subcommittee.

In this statement we will confine ourselves to the experience which we have had in Harris County with the Atomic Energy Commission, as well as with their rules and regulations. It is our sincere belief that this problem can be handled only by active participation on the local level and that it cannot be done from an office in Washington, D.C., Albuquerque, N. Mex., or from other localities outside of the local jurisdiction. It is our contention that whenever the local authorities, be it a health officer or a city administration or a county government, request that the Atomic Energy Commission apply stricter measures within that local area, it should be done without question as long as the minimum standards which the Atomic Energy Commission promulgates are met. In other words, it is our contention that the local health officer is better able to determine which actions are best to protect the health of the community in which he serves than anyone sitting in an office far removed from the local scene.

In the few inspections where personnel from the air and water pollution control section has accompanied Atomic Energy Commission inspection engineers, instances have been found where holders of AEC licenses were disposing of combustible contaminated wastes by incineration. Under the Atomic Energy Commission regulations, these areas should be plainly marked and fenced to protect those who are not aware of the danger from being exposed. We have found incineration being done in old drums with no special care being taken to contain or remove the ashes, nor has there been any fence which would hinder unauthorizd personnel from entering the area. In other instances this incineration was being done in a small gully, which was a drainage path for rainwater. The contaminated ashes were thereby removed by this rainwater and carried on into a nearby bayou. We have observed that in numerous instances the inspection engineers have not bothered to view the disposal area and so do not see the true situation. In this connection we strongly urge that a stricter inspection routine be adopted. Our local group will aid in organizing a stricter surveillance and we believe that this cooperation will be of mutual benefit.

In further consideration of the cooperation between the Atomic Energy Commission and State and local jurisdictions, it should be pointed out that to our knowledge there has never been any contact made with the county health unit prior to the licensing of a company or an individual, with the exception of the proposed licensing of the Industrial Wastes Disposal Corp. of this city. We firmly believe that such contact and cooperation should be routine so that complete information about the materials to be used and the applicant will be available to both the Atomic Energy Commission and the local health authorities.

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On recent investigations by engineers of the Atomic Energy Commission, made in the company of a representative of the Harris County Health Unit, the AEC engineer has specifically advised various license holders to rid themselves of small quantities of radioactive materials by flushing them down the sewer lines. While this practice might be sanctioned by the Atomic Energy Commission rules and regulations and be entirely safe in those areas where the sewers ultimately dump into a large body of water, it is our own opinion that it is not safe in this area because—

1. The sewage sludge is used for the manufacture of fertilizer and then is spread in gardens and returns to the food cycle of man.

2. About 50 percent of the sewage in the Houston-Harris County area is dumped in a raw state into bayous which have little or no flow.

3. The effluent discharges from the sewer plants again hit bayou with very minor dilution.

In this county, at least, it is our purpose to prohibit the discharge of any radioactive material into any sewer line, ditch, storm sewer or bayou, as far as it is humanly possible. We have furnished detection equipment to our air and water pollution control section and routine samples are being collected of the sewer plant effluents, as well as all streams within the county. Under the laws of this State, the introduction of any radioactive waste material is a violation, and it is our firm resolve to prosecute the violators to the limit of the law.

Experiments which have been done by the Atomic Energy Commission on flowing streams, such as the Columbia and Mohawk Rivers, cannot be compared at all to the situation which exists in the streams of Harris County. Since there is essentially no flow other than tidal action, we are particularly disturbed as to the possibility of danger and/or destruction to the marine life of Galveston Bay, because of discharge of radioactive materials. There is considerable fishing, shrimping, oystering, and crabbing done in this area, both for pleasure and profit, and we would dislike seeing anything happen that would destroy the life within our streams or make it hazardous for humans to consume. Since we have not had adequate experimentation, it is our sincere belief that prohibition of radioactive discharges should be enforced until more information is available. To support this fact, one has only to remember that once a stream is contaminated, it cannot be decontaminated by any human actions. It is better to make haste slowly rather than to be sorry later.

At the present time there is a need for further research on the handling and concentrating of radioactive waste materials. We are sure that a considerable amount of it is being done, but we also feel that the use of arid areas in this State for the holding or burial of these materials should be made. Granted, it would require that the areas be fenced and held under the control of the U.S. Government so that no hazard to unwary citizens would arise. In this connection, the discharge of these materials into the ground seems inadvisable because once the water table is contaminated, it is too late to take protective steps. In our county we will prohibit such discharges to the best of our ability in an effort to protect our subsurface waters from any contamination.

While we are not attempting to indicate by this statement concerning the disposal of radioactive waste materials that we have the ultimate or the highest authority and knowledge concerning them, we do feel that we have qualified experts who have experience in waste disposal techniques and are competent to judge whether or not a given proposal could be expected to be a hazard to the health of the people within this county. We also believe that strict enforcement of the laws of this State must be done, regardless of any permission which may have been granted by the Atomic Energy Commission for the discharge of these wastes. It is our purpose to evaluate each situation as it arises and determine, to the best of our ability, any hazard which might be involved. Undoubtedly, mistakes will be made, but we will endeavor to keep the overall picture well on the safe side.

In summation we would like to reiterate that at the present time the Atomic Energy Commission does not work in cooperation with the local governing group of Harris County nor its health department. We deplore this situation and feel that it should be remedied. In addition, we feel that the greatest good can come to the public by stricter regulations and enforcement. Naturally, the enforcement part must come from the local organization because the Federal Commission and its staff are too far removed to provide close supervision. In re-

turn, however, it would be expected that representatives of the Atomic Energy Commission would honor the rules and regulations as devised by our local health unit and their representatives, instead of opposing or ignoring them.

HON. BILL ELLIOTT,
Judge, Harris County.
W. KYLE CHAPMAN,
Commissioner, Precinct No. 1.
V. V. RAMSEY,
Commissioner, Precinct No. 2.
PHILIP E. SAYERS,
Commissioner, Precinct No. 3.
E. A. LYONS, Jr.,
Commissioner, Precinct No. 4.

U.S. ATOMIC ENERGY COMMISSION,
Washington, D.C., February 9, 1959.

In the matter of Industrial Waste Disposal Corp. application for waste disposal license, Docket No. 27-9.

Mr. JAMES T. RAMEY,
Executive Director, Joint Committee on Atomic Energy,
Congress of the United States.

DEAR MR. RAMEY: This is in response both to your letter of January 10, 1959, and the commitment made by Dr. Joseph Lieberman at the January 29 session of the Joint Committee hearing on waste disposal.

We are enclosing, in two volumes, the transcript of the hearing in the above captioned case which took place in Houston, Tex., January 22-23, 1959.

In addition to the applicant for the license and the AEC staff, Harris County, the city of Corpus Christi, Nueces County, the Nueces County Navigation District, and the Sportsmen's Clubs of Texas formally intervened and participated. Also observers or representatives of the following were officially recognized and, in some instances, participated by statements or otherwise; the Government of Mexico, the Governor of Texas, the Texas State Department of Health, the Texas Game and Fish Commission, the city of Houston, the University Oaks Civic Club, and the McGregor Trail Civic Club. The principal issues concerned the safety of the proposed operation, both at the storage site and in the course of disposal at sea. At the conclusion of the hearing the presiding officer fixed a scheduled for the filing of proposed findings and briefs. Based thereon, a decision is not likely to be rendered until after April 1, 1959.

Sincerely yours,

HAROLD L. PRICE,
Director, Division of Licensing and Regulation.

(The intermediate decision of the hearing examiner, issued May 29, 1959, follows:)

UNITED STATES OF AMERICA, ATOMIC ENERGY COMMISSION

Docket No. 27-9

IN THE MATTER OF INDUSTRIAL WASTE DISPOSAL CORPORATION

Appearances: John S. Kiibler, Jr., Esq., for Industrial Waste Disposal Corporation; Herzel H. E. Plaine, Esq., for the Staff of Atomic Energy Commission; Franklin L. Smith, Esq., county attorney, for Nueces County, Texas, City of Corpus Christi, and Nueces County Navigation District; E. W. Newman, Esq., for Sportsmen's Clubs of Texas; Joseph Resweber, Esq., county attorney, Harris County, Texas.

INTERMEDIATE DECISION

Industrial Waste Disposal Corporation (Industrial or Applicant) filed an application dated January 13, 1958, with the Atomic Energy Commission for a license authorizing Industrial to receive, package, and store for a limited period of time low level radioactive waste materials at 5420 Calhoun Street in Houston, Harris County, Texas, and to dispose of this waste material at a point off the coast of Texas in the Gulf of Mexico. On December 5, 1959, the Commission, after an analysis of the application and the amendment thereto, published in the Federal Register a Notice of Proposed Issuance of Byproduct Material License

to Industrial to authorize it to provide this radioactive waste disposal service. The Notice stated that the license would be issued unless a formal hearing was requested. On December 31, 1958, in view of the public interest expressed in this proceeding, the Commission issued a Notice providing for formal hearing to be held on January 22, 1959, at Houston, Texas. At the Hearing so convened, in addition to Industrial and the Staff of the Commission, intervention was granted and appearances were made by Sportsmen's Clubs of Texas, County of Harris, Texas, and County of Neuces, Texas, City of Corpus Christi, Texas, and Neuces County Navigation District, all of which interveners oppose the granting of the requested license. Limited appearance was permitted to Thais Harris, an individual, of Houston who did not appear but submitted his views by letter. P. M. Fitzhugh and N. N. Cabeness requested permission to make a limited appearance but did not appear at the hearing. Two persons appeared and made statements on behalf of various civic clubs and organizations in Houston; H. M. Greenwood presented the views of the MacGregor Trail Civic Club, R. N. Jonas made a statement on behalf of University Oaks Civic Club and the Allied Civic Clubs; all of these statements opposed the granting of the proposed license. Certain persons were present and observed but did not participate in the hearing, Dr. Ernest F. Gloyna, of the University of Texas, for the Governor of Texas; Messrs. Martin C. Wukasch and Herbert A. Bevis for the Texas State Department of Health; Messrs. Terrance R. Leary, R. Mareks, R. P. Hofsetter, and Joe B. Browers for the Texas Game and Fish Commission; and Messrs. Alan Love, Harvy Mobley, Fred Lang, and M. M. Sullivan for the City of Houston, Texas, at the request of Mayor Lewis Cutrer. The record also reflects the views of the Houston Health Department whose Public Health Engineer concluded, after study, that the proposed waste disposal service was needed in Houston and that it could be operated without unnecessary danger to the public health.

The Government of Mexico, pursuant to arrangements between the Commission and the State Department, was invited to be present and to participate in the hearing. In response thereto, present were the Counsel of Mexico, Hon. Alejandro V. Martinez, and two physicists, Messrs. Joseph Telich and Jose Alvares. Inquiry was made of the counsel at the hearing whether cross examination by him was desired for any of the witnesses; on one occasion this opportunity was utilized in order to ascertain if any specific tests had been undertaken at the exact site proposed to be utilized for the dumping operation.[1]

The hearing was held on January 22 and 23, 1959, in Houston, and a total of seven witnesses presented evidence. Proposed corrections to the transcript were authorized after extensions granted for preparation, by the order issued March 4, 1959. Proposed findings and conclusions, or objections thereto, were filed by all of the parties hereto at various dates extending from March 9 to April 30, 1959.

Industrial is an existing chemical waste disposal organization, disposing of such refuse material in the Gulf of Mexico and rendering service for business organizations in the Houston and general Gulf area. The application herein concerned seeks to enlarge that disposal activity by adding the low level nuclear wastes to the service in the Gulf, but at a specific location, farther from the coast and at a greater depth. This service would require that the transportation, packaging, and storage duties be in accordance with both Interstate Commerce Commission and Atomic Energy Commission regulations, and respecting sea transportation, in conformity with additional United States Coast Guard regulations. The proposed nuclear waste disposal would be offshore approximately 150 miles and at a depth of 1,000 fathoms or 6,000 feet. In the performance of the existing chemical waste disposal, the personnel of Industrial have made studies of the Gulf currents and tides and generally of the diffusive qualities of the waters. The President of Industrial has reported the results in various technical publications. The proposal presented by the application herein is based upon the belief by Applicant, and concurred in by the Staff of the Commission, that the proposed nuclear waste disposal service is needed and is feasible, particularly in the Houston area, in the light of the growing uses made of various radioactive isotopes by laboratories, hospitals, and industrial organizations.[2] These users operate instru-

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[1] In addition, Staff counsel inquired if there was any question not fully answered, and offered to provide any desired material for the Government of Mexico, and lacking any request, he stated that he assumed their problem was covered.

[2] There are an estimated 80 isotope licensees in Houston, and more throughout the State of Texas, any one of whom is a likely customer of Applicant.

ments and equipment possessing as much as 1,500 curies in one unit, whereas, by way of contrast, the Applicant would be limited to a possession of only 10 curies in the aggregate of all waste material at one time awaiting disposal at sea, and further limited to a maximum of 2 curies in any one container of waste. The laboratory, hospital, and industrial organizations use the radioactive isotopes under licenses requiring compliance with regulations of and inspection by the Atomic Energy Commission; the same type of procedure would be applicable to Industrial if the license is granted. The premise for the regulations and inspection is the determination of permissible limits of exposure to the radioactive materials, whether there be isotopes or waste refuse. The regulations have been formulated after study, research and consideration of the best available scientific data; the inspection is undertaken by qualified personnel using reliable testing instruments; the same type of inspection is performed in the hospitals, laboratory and industrial organizations as would be for Industrial in all aspects of its procurement, transportation, storage, and disposal activity.

At the outset, it must be remembered that the presentation made here by the Applicant is based upon the firm intention of full and complete compliance with all applicable regulations. In addition, it must be borne in mind that in any license proceeding, if modification of any performance is deemed advisable or necessary in the interest of safety, after the issuance of a license, the proceeding can be reopened, evidence presented, and modification made. The determination reached in this instance in this proceeding is not final to that extent; and if in the future, reliable evidence indicates that further consideration should be given to the mode of performance under the license, or any related aspects of the waste disposal service, upon application to the Atomic Energy Commission, determination can be made whether this proceeding should be reopened and any change made in the license.

The proposed processing of this nuclear waste material is briefly, as follows; after the licensees of the active radioisotopes have completed their use, it is required that the licensees place their liquid or solid wastes in specified containers, and to be thereafter placed in steel cylindrical drums, approved as satisfactory by regulation of the Interstate Commerce Commission, which prescribes this process if shipment is to be made. If the waste material is liquid, ICC regulations further provide that sufficient absorbent material shall be added into the steel drums so that any break will not allow the liquid waste to spill. If the waste material is solid, such as broken glass, instruments, absorbent rags, cleaning cloths, or contaminated clothing, the packing must be done to prevent the presence of any significant voids in the drums. After this packing and shipment in the steel drums to the receiving and storage location, the Applicant will then add a reinforcement of steel wire mesh and concrete as additional shielding and weight to each of the separate drums. The amount of concrete to be added will be in conformity with further requirements to permit the concrete enclosed steel drum to sink in 1000 fathoms or more of water.[3] The Applicant will not open any steel drums received by it, but will only use a concrete reinforcement to encase them, store them for a period not to exceed 21 months (but at no time in excess of a period where radioactivity will be beyond levels permitted by regulations and the proposed license requirements of a total of only 10 curies stored at one time) and later load the accumulation of drums on its ship for deposit in the Gulf under Coast Guard direction.[4]

Up to the point of the waste material reaching the storage and concrete processing location, that is, the procurement of the nuclear waste material from the licensed users and transportation thereof over the streets of Houston or other roadways,[5] the issues of safety appear to be without question and satisfactory even to the intervenors herein, who object principally to (1) the location of the storage area at 5420 Calhoun Street in Houston, and (2) the claimed uncertainties of the effects upon marine life. Related to the sea disposal aspect,

[3] As processed and encased by Applicant, the drums will meet the recommendation of the National Committee on Radiation Protection as given in the National Bureau of Standards Handbook 58 "Disposal of Radioactive Waste in the Ocean."

[4] Some intervenors objected that there was not any assurance that the ship would be competently directed in order to reach the specified deposit location; it is believed that the Coast Guard licensing of helmsmen can be relied upon to overcome that objection.

[5] Apparently the only requirement for "over the road" shipment of nuclear waste material, after the packaging above described, is special labelling on the specified containers and on the vehicles. No convoys or special escorts are required for the vehicles. These ICC requirements apply equally to packages containing active radioisotopes as to packages containing waste materials; the level of the radioactivity below permissible limits is the only criterion.

the intervenors also contend that not enough is known whether injuries might be sustained by persons on the Gulf Coast, and therefore the license for disposal service should not be granted.

Those persons, while not intervenors but who were permitted to make statements at the hearing, and who also objected to the location of the storage area on Calhoun Street, appear to base their positions primarily on the ground that they live near the area. These objections seem to be based more on their views of uncertainty of what might happen; and likewise, the objections or resolutions of the civic clubs opposing the storage area appear to be based upon an inherent dislike for any nuclear waste material, rather than directing attention to the level of the radioactivity, which is the all important aspect.[6] There apparently is no objection by these civic club representatives to the present sewage waste disposal in Houston of some radioactive liquids. The level of this radioactivity is below permissible levels and is safe; the Health Department of Houston keeps constant check on this disposal method.[7]

It would seem at first glance that it would be far better to permit a nuclear waste disposal service to be activated, rather than to let the solid material, for instance, accumulate. Other disposal methods could be utilized under proper regulations, such as incineration or burial in the ground, but sea disposal is preferred because of the lack of any contact by humans with the deposit location and the absence of any significant increase to the radioactivity naturally present in the oceans.

The effects of, and the lack of any real danger from the low level character of the waste material here involved have been illustrated in many ways, including computations of whether a person could stand next to the storage building for an hour without any harmful biological effects,[8] and whether a person might drink water, otherwise potable, after 30 hours, if all the waste material of 10 curies were not only dumped into the water, but with the worst isotope therein contained, and immediately released from the containment and diffused in the water. Consideration of such possibilities shows that there is not a serious danger from either such event. From the aspect of the street location in Houston, the objections do not appear well founded by any proof of competent scientific data that either any person or the surrounding residents would be biologically injured. The location objection was asserted to be based upon either a dislike for any industrial activity in the particular area, or the nebulous dislike of anything atomic in character as injurious per se.[9] The area of this proposed storage operation is on a bayou in south Houston, the dock facilities of which are used for oyster unloadings and is adjacent to a concrete processing plant, and nearby are other commercial establishments. Two hundred yards from the storage location is a residence; two blocks away is a small recreational park, beyond and surrounding which is a residential area. Upon a direction to investigate issued by the Mayor of the City of Houston, the Public Health Department of Houston could find nothing objectionable with the proposed activity at

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[6] The important aspects of this consideration were well stated at the hearing as follows: "The word 'radioactive' has been so strongly impressed that it has become an all inclusive descriptive term to the point where important characteristics of wastes, such as quantity of radioactivity, concentration of radioactive material and detailed chemical and physical nature are often overlooked; yet, these characteristics are the keys to proper understanding and discussion of radioactive waste operations."

[7] Radiographers in Houston, using isotopes near full strength, regularly and possibly daily transport over city streets such nuclear sources that may range from 3 to 12 curies, the persons making limited appearances as well as the intervener County of Harris, have apparently found no danger in that activity, even though the travel may be on a street immediately adjacent to their homes, while objecting to Applicant's storage in a building in south Houston of a maximum limit of 10 curies of radioactivity.

[8] The limit here specified in proposed license is 2 milliroentgens per hour; this limit was described as less contamination by radioactivity than might be received from a wristwatch that "glows" in the dark.

[9] One speaker said, "I personally understand that Dr. Hood, Miss Wood, are perfectly competent to handle these materials safely. Most of their employees are experienced, and would not do wrong in the slightest degree. But to the layman, for many years to come, radioactivity will mean one thing: Danger. * * * value of his property will rapidly decline because of the mere presence of this thing."

Another speaker said, in part, "* * * the feeling is, to grant the permit (license) to the plant in question is perhaps not harmful in view of all of these technical items, but people feel it is harmful * * * a feeling that we are not far enough along to assure safety in this type of operation. * * * I am not afraid of it myself * * * (as to Calhoun Street). There is just a small industrial area * * * the residents of the area around there have been battling to keep it residential and keep out industrial sites * * * if this permit is granted, this will be just something that will bring in more later * * * one of the troubles in Houston is we don't have zoning and each individual area has to fight its battle." (Parentheses added.)

the storage area. The real concern in this proceeding is the reliability and safety with which the service is performed. The personnel of the applicant appear to be highly qualified and capable; even the health witness of the intervenor County of Harris commended two of the Applicant's personnel, his fear was that perhaps their other employees might not be as good. From the record, Applicant's personnel appear to be undertaking the present chemical waste activity without violations of regulations there appertaining; this experience is some basis to expect the same performance respecting a nuclear waste activity.

A considerable portion of the testimony was directed to the sea disposal activity, involving the deposit of the waste materials approximately 180 miles south of Galveston, Texas, and approximately 150 miles east of Port Isabel, Texas, and within 5 miles radius of the point designated as parallel of Latitude 26° 20′ north and meridian of Longitude 94° 32′ west, where the depth is at least 1,000 fathoms. The disposal area is at the edge of the continental shelf and is comparable to areas in the Atlantic Ocean which have been used for deposit and disposal of low level radioactive wastes since 1951.

It is estimated that the Applicant herein will deposit a total of 240 curies of waste material during the 2 year period of the license; one deposit area in the Atlantic already has received a deposit of 6,000 curies, and tests undertaken in 1956 have revealed that there has not been any harmful effect on marine life, or the sea water, and that no persons on the coast have been harmed in any way.

Disposal of packaged low level wastes in the sea at depths of 1,000 fathoms or more has been recommended by the National Committee on Radiation Protection, has not been disproved by any scientific data, and has been supported in actual practice by tests of the disposal areas in both the Atlantic and Pacific oceans, and by studies and recommendations of the National Academy of Sciences subcommittee appointed to investigate the feasibility of disposal of radioactive waste in the inshore waters on the east and Gulf coasts of the United States. The only witness who appeared in opposition to the sea disposal proposal relied in part upon some scientific data, which it appeared, supported sea disposal if at a depth of 1,000 fathoms or more.

One of the witnesses presented by the Staff who supported the proposed sea disposal activity was Chairman of the subcommittee on sea disposal of the National Academy of Sciences, and is an associate professor of oceanography at Johns Hopkins University in Baltimore. His experience in oceanography includes studies of both the Atlantic and Pacific accepted sea disposal areas near the coast of the United States. The study undertaken by the foregoing described subcommittee had as its main concern the prevention of the return of radioactive materials to man after its deposit in the ocean, in any way which would be harmful to him. This involved a study of both the marine life, which might be ingested, and the water activity, either currents or tidal, which would in any way affect man biologically. This work also included a testing of the sea deposit areas off the New Jersey Coast. Based upon this background, the witness expressed the opinion that the Gulf deposit area proposed to be used by the applicant was safe, and would not result in harmful radioactive injury to man, either from marine life, or action of the waters of the Gulf. The witness further stated that the Gulf has the basic chemical, biological, and physical properties common to the Atlantic and Pacific oceans, and that the proposed disposal site is oceanographically comparable to the disposal areas used in the Atlantic and furthermore, going to greater depth than 1,000 fathoms would offer no greater safety. The representatives of the Government of Mexico developed on cross examination that no specific tests had been made of the currents or marine life at the specific point of the proposed deposit of waste material, for the witness concluded that there was not any need of such studies. There are no fisheries, and no fishing is done at a depth of 1,000 fathoms, in fact, most marine life, whether for commercial or sport fishing, is above 100 meters or 300 feet. The witness had mentioned the previous studies of further inshore waters, as suitable deposit areas, and concluded that deposit of low level wastes was as safe as any condition involving natural factors can be concluded. In some of the inshore areas of the Gulf, however, involving lesser depths than here concerned, the Science Academy Committee felt that further investigations would be needed to ascertain if fisheries might be affected but in the opinion of the witness, the Applicant's offshore site here was beyond that range and was safe. The bottom currents of the Gulf of Mexico at the proposed disposal site, which is very deep water, are practically nil, and consist of only a slight oscillatory stirring action. The surface currents in this area (so-called shelf or offshore currents) are about one-third of a knot average strength, and tend to move inward, at times, during

the year in the direction of Corpus Christi and Brownsville. However, these offshore or shelf surface currents converge with the inshore currents running along the coast and the converging water sink down, and flow outward away from the coast presenting no real danger of sweeping deleterious material onto either the coast of Texas or Mexico. Mexico has even further protection from any possible harmful effects of currents in that the inshore currents run from south to north from Tampico to Brownsville. The fact is that the effect of the currents are helpful in any event rather than harmful, in that they increase the diffusion of the radioactive materials in the water, and reduce the concentration in a short space and time. The type of packaging makes it highly improbable that any solid materials would come free from the package and float to the surface.

Important in this regard is that the proposed deposit of 240 curies over a period of two years nuclear waste material is infinitesimal in relation to the billions of curies of background radioactivity now in the Gulf, which has existed for centuries and if natural conditions prevail, will continue to exist. The deposit of 240 curies over 2 years will not introduce any significant reactivity, and will not measurably affect the level of radioactivity already present. It would seem that marine life and persons on the coast are not affected by the existing radioactivity, and an immeasurable addition will not threaten humans in any way. The alarm of the intervenors appears to have overlooked these existing natural conditions, and even their expressions of fear of bathing in the Gulf have disregarded the daily present exposures that are not harmful. As the Commission's staff witnesses emphasized, the real concern is to never let the exposure, whether on land or in the sea, rise above permissible levels, that is, above that measure which all available scientific data indicates is safe to man.

Bearing in mind that the applicant's proposed waste disposal activity limits applicant to a level of 2 curies for each single steel drum, to a total of 10 curies for any accumulation at one time, and a total of 240 curies to be deposited over a 2 year period, the testimony in this case is that if one assumed the unlikely, nevertheless, but immediate release from containment of a maximum deposit of 10 curies of radioactive waste (5 drums containing 2 curies each) upon its hitting the bottom of the sea at the place of deposit, and further assumed there were no currents or movements other than the diffusive mixing movements of natural waters, the computation was made that within 30 hours the area of deposit would be reduced to a level within the maximum permissible concentration for drinking water. The maximum permissible concentration in the sea for fish is the same as the maximum permissible concentration in drinking water for man. If there is added to the example, the factor of a current, because of the greater mixing effect caused by currents, the period of time would be less. If the example is calculated in terms of distance, rather than time, again assuming 10 curies of radioactivity released at the bottom at once without any current, if one were at a distance of 2 kilometers (1¼ miles) when the water was transported by the process of natural diffusion, the water would meet the standards of concentration permissible in drinking water. If there be assumed a five knot per day current, assisting the movement of the water, the concentration would go down to permissible levels for drinking water in a distance of 1 kilometer (⅝ mile). If there be further assumed a 1,000 curie quantity (100 times 10 curies) with a five knot current, the distance required would be between 13 and 20 kilometers. All of these calculations were made under extreme hypotheses such as, taking no account of the containment by the packaging which is estimated to be about 10 years, taking no account of the absorption or containment afforded by the binding of radioactive materials on the bottom deposits of the ocean, and making all calculations on the exaggerated assumption that all of the radioactivity is the worst isotope from man's standpoint, strontium 90. This latter assumption, among other things, also eliminates the decay factor in the case of the short-lived radioisotopes. In addition, the maximum permissible concentration values have a wide margin of safety factored into them and they represent lifetime values.

Upon the basis of all of the evidence in the proceeding and the proposed findings and conclusions which are accepted, modified or rejected as herein shown in substance, and in addition to the foregoing findings and conclusions it is found that:

1. Applicant, Industrial Waste Disposal Corporation, is a duly qualified person shown to possess competent and reliable personnel and is entitled to receive a license from the Atomic Energy Commission for the nuclear waste sea disposal activity described in its application and amendments thereto.

2. The nuclear waste disposal service described by the Applicant and proposed to be undertaken in accordance with the rules and regulations of the Interstate Commerce Commission, Atomic Energy Commission, and United States Coast Guard will not be inimical to the health and safety of the public.

3. The Applicant's proposed equipment, facilities and procedures are adequate to protect health and minimize danger to life and property.

4. The Applicant is qualified by training and experience to conduct the proposed nuclear waste disposal service in such a manner as to protect health and minimize danger to life and property.

5. Applicant's waste disposal operation will be performed in accordance with the provisions of 10 CFR 20, 10 CFR 30, and other applicable Commission regulations, and the conditions of the proposed license.

Wherefore, IT IS ORDERED, subject to review by the Commission on its own motion, or upon appeal after exceptions filed by the parties hereto:

A. A license in the form annexed hereto is granted to Industrial Waste Disposal Corporation.

B. The date of issuance and service of this intermediate decision is May 29, 1959, and exceptions, if any, hereto and briefs in support of such exceptions shall be filed on or before June 19, 1959; briefs, if any, if opposition to such exceptions shall be filed on or before June 23, 1959. In the absence of any exceptions being filed, or in the absence of any review by the Commission on its own motion, this intermediate decision shall become final on June 20, 1959.

SAMUEL W. JENSCH,
Presiding Officer.

GERMANTOWN, MARYLAND, *May 29, 1959.*

ANNEX "A"

BYPRODUCT MATERIAL LICENSE INDUSTRIAL WASTE DISPOSAL CORPORATION

Docket No. 27-9

License No. 42-4230-1
(K60)

Pursuant to the Atomic Energy Act of 1954, as amended, and Title 10, Code of Federal Regulations, Part 30, "Licensing of Byproduct Material," and in reliance on statements and representations heretofore made by the applicant, a license is hereby issued to Industrial Waste Disposal Corporation, 5420 Calhoun Street, Houston, Taxes, to receive, possess, package, and dispose of byproduct material in the Gulf of Mexico.

This license shall be deemed to contain the conditions specified in Section 183 of the Atomic Energy Act of 1954, as amended, and is subject to the provision of Title 10, Code of Federal Regulations, Chapter 1, Part 20, "Standards for Protection Against Radiation," and all other applicable rules, regulations, and orders of the Atomic Energy Commission now or hereafter in effect and to the following conditions:

1. The licensee shall not possess more than 10 curies of byproduct material at any one time.

2. Byproduct material shall be received, packaged, and disposed of by, or under the direct supervision of John G. Davis or Donald W. Hood.

3. The licensee shall receive, package, possess and dispose of the byproduct material in accordance with the procedures described in the licensee's application dated January 13, 1958, and attachments thereto; and the licensee's letters including enclosures, dated February 25, 1958, July 11, 1958, August 7, 1958, September 8, 1958, and November 25, 1958; except as provided otherwise in this license.

4. A copy of Industrial Waste Disposal Corporation's "Safe Handling Procedure For Radioactive Waste" attached to letter dated August 7, 1958, shall be supplied to each individual involved in the receipt, packaging, and disposal of byproduct material.

5. Waste containing byproduct material shall be packaged by persons from whom the licensee receives waste byproduct material in accordance with the specifications contained in Condition 7 of this license and the containers shall not be opened by Industrial Waste Disposal Corporation.

6. The licensee shall instruct each customer to package the waste material in such a manner as to assure the absence of any significant voids.

7. The transportation of AEC licensed material to and from the location designated in Condition 8 shall be subject to the applicable regulations of the Inter-

state Commerce Commission, U. S. Coast Guard, and other agencies of the United States having appropriate jurisdiction, and where not applicable shall be in accordance with the following requirements; except as specifically approved by the Atomic Energy Commission:

A. *Outside Shipping Containers.*—(1) The containers shall meet any one of the following specifications described in Appendix A attached hereto:

a. 15A, 15B, 6A, 6B, 6C, 17C, 17H, 19A, or 19B for the containment of radioactivity in amounts not in excess 2.0 curies; or

b. Specification 55 for containment of solid cobalt 60, cesium 137, iridium 192, or gold 198 in amount not in excess of 300 curies.

(2) There shall be no radioactive contamination on any exterior surface of the container in excess of 500 d/m/100 sq. cm. alpha and 0.1 mrep/hr beta-gamma radiation.

(3) The smallest dimension of the container shall not be less than 4 inches.

(4) The radiation level at any accessible surface of the container shall not exceed 200 mrem/hr.

(5) At one meter from any point on the radioactive source the radiation level shall not exceed 10 mrem/hr.

(6) Containers which contain radioactive material emitting only alpha and/or beta radiation shall contain sufficient shielding to prevent the escape of primary corpuscular radiation to the exterior surface and to reduce the secondary radiation at the surface of the container to at least 10 mrem/24 hours at any time during transportation.

B. *Inside Containers.*—(1) Solid and gaseous radioactive materials shall be packed in suitable inside containers designed to prevent rupture and leakage under conditions incident to transportation.

(2) Liquid radioactive materials must be packed in sealed glass, earthenware, or other suitable containers. The container must be surrounded on all sides by an absorbent material sufficient to absorb the entire liquid contents and be of such nature that its efficiency will not be impaired by chemical reactions with the contents. Where shielding is required the absorbent material must be placed within the shield. If the inside container meets the Specification 2R in Appendix A the absorbent material is not required.

(3) Materials containing radioisotopes of plutonium, americium, polonium, or curium, or the isotope strontium 90, in quantities in excess of 100 microcuries, must be packed in containers which meet Specification 2R in Appendix A.

C. *Shielding.*—Inside containers must be completely surrounded with sufficient shielding to meet the requirements of Subparagraphs A (4), A (5), and A (6) of this condition. The shield must be so designed that it will not open or break under normal conditions incident to transportation.

D. *Labeling.*—Each outside container label required under Section 20.203 (f) of 10 CFR 20 shall bear the following information:

(1) total activity in millicuries, or in the case of source and special nuclear material, the total weight;

(2) principal radioistope

(3) radiation level at the surface of the container and at one meter from the source; and

(4) the name and address of the licensee.

E. Each vehicle in which licensed material is transported shall be marked or placarded on each side and the rear with lettering at least 3 inches high as follows: DANGEROUS—RADIOACTIVE MATERIAL.

Accidents.—In the event of an accident involving any vehicle transporting licensed material, immediate steps shall be taken to prevent radiation exposure of persons and to control contamination.

G. *Exemptions.*—Specific approval must be obtained from the Atomic Energy Commission for modification of, or exemption from, the requirements of this license condition. Requests for such approval should be directed to the Chief, Isotopes Branch, Division of Licensing and Regulation, Atomic Energy Commission, and should contain sufficient information to support such a request.

8. The licensee shall store and package by product material for sea disposal at 5420 Calhoun Street, Houston, Texas, as described in licensee's application.

9. The licensee shall notify the Chief, Isotopes Branch, Division of Licensing and Regulation, Atomic Energy Commission, at least 20 days prior to each disposal, by letter deposited in the United States mail properly stamped and ad-

dressed, of the proposed dated for disposal, the total number of containers, the total activity in millicuries, and the most hazardous radioisotope contained in each container.

10. The licensee shall dispose of byproduct material in the Gulf of Mexico at a point designated as parallel of Latitude 26° 20′ N. and meridian of Longitude 94°32′ W. at a minimum depth of 1,000 fathoms.

11. Byproduct material shall be disposed of at sea within 21 months from the date on which the Industrial Waste Disposal Corporation first takes possession of such material.

This license shall be effective on the date issued and shall expire two years from the date of issuance.

For the Atomic Energy Commission:

JAMES R. MASON,
Chief, Isotopes Branch,
Division of Licensing and Regulation.

Date at Germantown, Maryland, this —— date of ——, 1959.

(Whereupon, at 1 p.m., Tuesday, February 3, 1959, the hearing was adjourned.)

NOTICE CONCERNING FORTHCOMING VOLUME V

On July 22, 1959, while Volumes I–IV of these hearings were in the process of printing and publication, the Joint Committee issued the following notice of a subsequent hearing to be held on ocean waste disposal:

[From the offices of the Joint Committee on Atomic Energy, No. 236, for release July 22, 1959]

RADIATION SUBCOMMITTEE TO HOLD HEARINGS ON OCEAN WASTE DISPOSAL

Congressman Chet Holifield, chairman of the Special Subcommittee on Radiation, announced today that the subcommittee had scheduled a public hearing for next Wednesday, July 29, 1959, at 2 p.m., on the subject of disposal of low level radioactive wastes into the ocean. Mr. Holifield stated that he was requesting representatives of the Atomic Energy Commission to testify, as well as experts from the National Academy of Sciences, which recently published a report entitled, "Radioactive Waste Disposal Into Atlantic and Gulf Coastal Waters," suggesting 28 possible locations for ocean disposal of low level wastes.

The special subcommittee held hearings from January 28 through February 3, 1959, on industrial radioactive waste disposal and received testimony from experts on all types of radioactive wastes and the AEC research and development program. The hearings next week have been scheduled to cover more specifically the subject of ocean disposal of low level wastes, and to obtain better public understanding regarding the criteria and procedures now being used to protect the public health and safety.

Mr. Holifield stated that the hearings had been scheduled at the request of three members of the Joint Committee: Senator Pastore, of Rhode Island; Congressman Thomas, of Texas; and Congressman Bates, of Massachusetts.

The record of the July 29, 1959, hearing will be published as Volume V of these hearings, and will be distributed to the public as soon as printing and publication schedules permit.

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